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Appendix 5-9
West Ridge Mine
Proposed Highwall Reclamation

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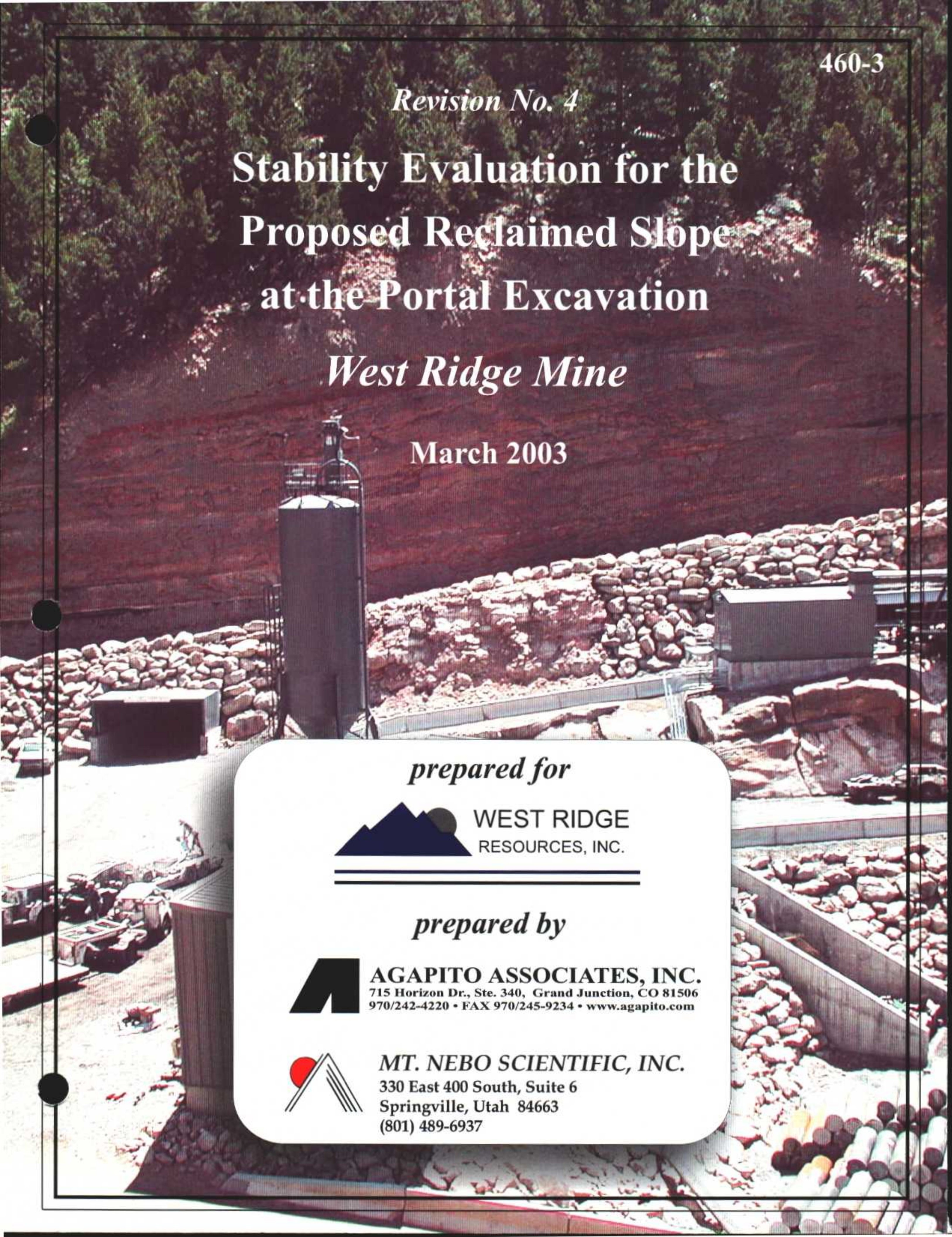

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Revision No. 4

Stability Evaluation for the Proposed Reclaimed Slope at the Portal Excavation

West Ridge Mine

March 2003

prepared for

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RESOURCES, INC.

prepared by

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West Ridge Mine

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1.0 INTRODUCTION

Agapito Associates, Inc., (AAI) and Mt. Nebo Scientific (Mt. Nebo), have prepared this report at the request of West Ridge Resources, Inc., (West Ridge) to provide design recommendations for reclamation of the cut slope above the mine portals at the West Ridge Mine. The West Ridge Mine is located near Sunnyside, Utah, as shown on Figure 1. A photograph of the portal cut slope is shown on Figure 2.

This document constitutes Revision No. 4 to the "Stability Evaluation for the Proposed Reclaimed Slope at the Portal Excavation, West Ridge Mine." This Revision No. 4 supersedes all other versions of this report. Revision No. 4 is a stand-alone document. No aspects of the foregoing versions of this evaluation should be transferred to this Revision No. 4.

AAI sampled existing and proposed slope materials, designed a laboratory testing program, analyzed the test results, developed a geotechnical slope stability model, analyzed several slope failure scenarios, and provided design recommendations for construction of the reclaimed slope. Mt. Nebo provided direction regarding the revegetation and aesthetics of the slope surface and developed a revegetation and erosion control design for the slope face.

The cut above the portals was excavated to provide a catch bench above the portals, as required by the Mine Health and Safety Administration (MSHA). The West Ridge reclamation plan specifies that reclamation of the portal cut slope will include backfilling against the excavated slope, after mining operations cease. The performance criteria for the slope are a static safety factor of at least 1.3 and a pseudostatic safety factor of at least 1.1. An additional key design criterion is eventual 70% revegetation of the face of the backfilled slope. The slope will also be free-draining, such that pore water pressure does not adversely affect slope stability. Another important design criterion relates to the toe of the backfilled slope, which is fixed at the toe of the lower bench, in accordance with the planned reclamation for the area below the slope.

AAI has performed four previous evaluations for the portal cut slope: AAI (1998), AAI (March 2001), AAI (June 2001), and AAI (January 2002). This report constitutes the fourth revision to the March 2001 report. The second report (March 2001) assumed that the cut slope was stable and homogeneous. The shear strength values for the Backfill material that were used were mean values of several laboratory tests performed by a previous investigator on colluvial material. The slope was modeled as dry because no seeps had been reported at the cut slope. The first revision to the March 2001 report (June 2001) was prepared in response to concerns by the Utah Division of Oil, Gas, and Mining (DOGM) that elevated pore water pressures, related to either surface water or ground water, could affect the stability of the slope, as modeled. To avoid the issue of pore water pressure, the approach taken in Revision No. 1 (March 2001) was to model the slope as a free-draining, non-cohesive, angular rockfill. The design incorporated pockets of vegetation on the backfilled slope face. The rockfill concept did not meet requirements of the reclamation plan because the vegetation density requirement of 70% was not perceived to have been met by DOGM.

The primary goal of Revision No. 2 (June 2001) was to develop a reclaimed slope design that satisfied the requirements of slope stability, pore water pressure, and vegetation density. Revision No. 3 (January 2002) was prepared to address "technical deficiencies" identified by DOGM during their review of Revision No. 2. Revision No. 3 designs incorporated compacted, well-graded material for Backfill. Pore water pressure resulting from any seeps that may occur at the cut slope, and increase pore water pressure in the Backfill, was addressed by incorporating a geosynthetic composite drain between the Backfill and the existing slope face and a rockfill toe drain.

This Revision No. 4 was prepared to address technical deficiencies cited by DOGM related to Revision No. 3. The approach used in this Revision No. 4 is summarized in the following section and detailed throughout this document.

2.0 SUMMARY

This Revision No. 4 includes a rigorous material characterization study and significant design changes, with respect to Revision No. 3 (January 2002). West Ridge has defined on-site sources of Backfill and Topsoil materials. The shear strengths and material characteristics of the Backfill source material, the Residual soil, and the Topsoil source material have been determined by laboratory analyses. A 4-ft-thick rooting zone has been incorporated in the slope design. The rooting zone will consist of 3 ft of Backfill soil, overlain by 1 ft of Topsoil. The rooting zone will be reinforced by a geosynthetic grid material recommended after analysis by Tensar. An evaluation of the potential impacts of preserving the experimental practice versus reclaiming the portal highwall at a slope angle that is less than 40 degrees is presented in a stand-alone document prepared by Blackhawk Engineering of Price, Utah.

West Ridge has committed to on-site sources of Backfill and Topsoil. Backfill material for the highwall will be excavated from the pad, currently occupied by the warehouse, and the pad at the elevation of the portals. Topsoil will be supplied from the Topsoil stockpile.

For this Revision No. 4, West Ridge has sampled all soils that exist on the slope or will be used to construct the reclaimed slope, and laboratory analyses have been performed on all of those soils to provide DOGM with complete and defensible shear strengths and material classifications. A complete list of geotechnical test parameters is provided in the following section. Soil chemistry testing is also being conducted for the Backfill and Topsoil. Soil chemistry analyses parameters were provided by Mt. Nebo. Mt. Nebo has reviewed the soil chemistry results and determined that the Backfill material is compatible with native plant species and plant species specified for the highwall revegetation.

Regarding shear strength of the bench at the base of the existing highwall, that bench is comprised of *in situ*, undisturbed rock, rather than compacted soil, as used by AAI in all previous analyses. The only fill areas on the bench are located directly above the three portals. Therefore, the bench will be assigned the shear strengths used in all previous analyses for "partially burned coal and interbedded sandstone and siltstone," because these geologic materials are present throughout the bench. During reclamation the portal overlying fill material, along with the steel supports and lagging, will be removed. The portal cuts will then be filled with the same compacted Backfill material that will comprise the majority of the reclaimed slope. A 2-ft-thick drainage layer will be placed at the base of the fill, which will be comprised of clean, free-draining angular rockfill, which is consistent with Revision No. 3 (June 2001).

Standard Proctor compaction tests have been conducted on the Backfill material to determine the optimum density and moisture content for placement. Direct shear tests are being conducted at 90% of Standard Proctor optimum conditions, and +2% above optimum moisture content.

West Ridge had previously agreed to conduct a test fill on the Backfill material. This was agreed to in lieu of defining a source of Backfill, to assure that the material could meet specifications used in the stability model. West Ridge proposes that defining the source of Backfill, and conducting compaction testing on that Backfill material, provide sufficient assurance that the material will meet specifications. This approach is typical for earthworks. West Ridge also proposes committing to lift thicknesses no greater than 6 inches to assure the compactive efforts reach the base of each lift. Therefore, West Ridge proposes that a test fill should no longer be required.

The issue of stability of the surficial rooting zone layer is being addressed by committing to a geosynthetic-reinforced slope face. Biaxial geogrid (Tensar BX1100 or Engineer approval equivalent) will be embedded in the Backfill. The distance between geogrid layers, or courses, will be about 2 ft. The rooting zone will not receive any compactive effort.

West Ridge proposes to use a 4-ft-thick rooting zone, comprised of a 3-ft-thick base layer of non-compacted Backfill material, overlain by a 1-ft-thick layer of Topsoil, in accordance with the aforementioned DOGM document.

West Ridge further proposes that the geogrid will reinforce and stabilize the surficial rooting zone. Geogrid reinforced slopes are typically constructed and fully vegetated at slope angles up to 70 degrees according to Tensar, a leading geogrid manufacturer, designer, and installer (Tensar 2003). This approach should eliminate the need for determining the angle of repose of the uncompacted Backfill material, as requested by DOGM. West Ridge could not find an acceptable method for determination of angle of repose, based on a search of ASTM methods and contact with several soils laboratories.

West Ridge has conducted a study to demonstrate the differences in environmental impacts between maintaining and abandoning the experimental practice to extend the toe of the reclaimed highwall slope. This study will be presented in Appendix 5-10.

3.0 GEOTECHNICAL MODEL

The geotechnical model is a cross-section through the slope at the most critical location on the slope, with respect to height and slope angle. By constructing the geotechnical model along the most critical section, the worst case is evaluated. The trace of the cross-section deviates from linear to maintain the steepest slope angle. This method of constructing an idealized critical cross-section is conservative because it combines worst-case elements from across the slope into a single cross-section. The location of the critical slope stability section is shown on Figure 3. The geotechnical model is similar to a geological model, except that it is comprised of "engineering lithologies." Engineering lithologies are defined by similarities in shear strength properties and other rock mass characteristics, such as geologic structure and weathering. The geotechnical model used in this evaluation is shown on Figure 4. The engineering lithologies are detailed in Section 3.2 and presented in Table 1.

Table 1. Summary of Engineering Lithologies

Engineering Lithology	Description
Basal sandstone	Competent massive sandstone
Coal	Partially burned coal, interbedded with siltstone and sandstone
Backfill	Silty, clayey, gravel with sand
Interbedded sandstone and siltstone	Competent interbedded sandstone and siltstone
Residual soil	Silty, clayey gravel with sand
Rockfill	Clean angular rockfill
Topsoil	Stockpiled Topsoil

The portal cut slope has about 300 linear ft of exposed slope face. The crest of the slope is accurate in profile, such that the slope is about 30 ft high at the east flank and reaches a maximum height of about 85 ft towards the middle of the slope face. The arc of the slope crest continues to undisturbed ground at the west flank. An approximately 20 ft high, 30 ft wide bedrock bench exists at the toe of the slope. The bench is faced with boulders and bedrock outcrops. A lower bedrock bench is exposed at the base of the southwest portion of the highwall. The bedrock above the portals was excavated during portal development. The bench was backfilled directly above the portals, after the portal supports were in place. This material will be removed and replaced with compacted Backfill material during reclamation. The angle of the portal cut slope is 73 degrees (with respect to horizontal). The natural slope above the portal cut has a mean slope angle of 32 degrees. The face of the proposed Backfilled reclaimed slope will be 40 degrees.

3.1 Geology

The West Ridge Mine is located within the Book Cliffs of the Colorado Plateau Geologic Province. The portal cut slope exposes units of the Cretaceous Blackhawk Formation. The Blackhawk Formation is comprised of interbedded quartzose sandstone, shaley siltstone, shale, carbonaceous shale, and coal (RB&G Engineering, Inc. 1999).

The uppermost unit of the slope is the surficial Residual soil that caps the natural slope above the cut slope face. The surficial Residual soil is about 10 ft thick. It is comprised primarily of silty sand with gravel. There are numerous sandstone outcrops exposed at the surface.

The slope face above the upper bench exposes interbedded sandstones and limestones. The rock is competent, with discontinuity spacings on the order of 1 to 3 ft. The pinkish color is indicative of a coal burn below the unit.

The Sunnyside Coal member underlies the interbedded sandstones and siltstones. Three coal seams occur, separated by sandstones and siltstones. The upper two seams are the Upper Sunnyside Coal, and the lower seam is the Lower Sunnyside Coal. The Lower Sunnyside Coal is being mined. The coal is partially burned near the portal cut. The burn is a few feet thick at the east end of the cut and progresses to about 240 ft in from the conveyor portal at the west end of the portal cut.

The basal unit, with respect to the portal cut slope, is the Lower Sunnyside Sandstone. The Lower Sunnyside Sandstone is a massive, competent quartzose sandstone.

The mean strike of joints in the units overlying the Sunnyside Coal is 105 degrees (AAI 1997a,b). Joints in the Blackhawk Formation were observed to be discontinuous, dipping nearly vertically, and rarely penetrating more than a few beds. The regional strike of bedding structures is about 135 degrees, with dips ranging from 2 degrees to 11 degrees, with a mean dip of 7 degrees to the northeast. The portal cut slope face strikes at about 60 degrees. Therefore, kinematic analyses were not conducted for the existing cut slope because joints are near vertical and discontinuous, and the bedding dip direction is roughly parallel with the slope face.

3.2 Engineering Lithologies

The engineering lithologies were defined for geologic and anthropogenic features. The "geologic" engineering lithologies are coincident with the geologic stratigraphy, except for the Upper and Lower Sunnyside Coal and interbedded clastic units, which were combined into one engineering lithology termed "Coal" with engineering properties of Sunnyside Coal (Schriebner 1979). Table 1 presents a summary of the engineering lithologies used in the geotechnical model.

The anthropogenic engineering lithologies include the Backfill for the reclaimed slope, the Topsoil, the rockfill that comprises the drainage layer at the base of the Backfill, and the geosynthetic products that are specified.

3.3 Shear Strength Parameters

Mohr-Coloumb shear strength parameters for the Backfill, Topsoil, and Residual soil materials were defined by laboratory testing conducted for this evaluation (Table 2). Shear strength parameters include cohesion and angle of internal friction. Shear strength parameters for the other engineering lithologies were estimated based on results from previous studies at the site. Laboratory

Table 2. Summary of Shear Strength Parameters Used in the Slope Stability Model

	Unit Weight (pcf)		Shear Strength	
Engineering Lithology	**Moist**	**Saturated**	**Cohesion (psf)**	**Internal Friction Angle (deg)**
Basal sandstone	155.0	155.0	111,168	45
Topsoil	130.0	130.0	1,700	39
Coal and interbedded sandstone and siltstone	78.6	78.6	14,112	35
Backfill material	138.0	138.0	1877	54
Interbedded sandstone and limestone	155.0	155.0	111,168	45
Residual soil	134	134	1,515	42
Rockfill	120.0	120.0	100	40
Geotextile composite drain	100.0	100.0	0	18

testing was essential for the Backfill and Topsoil materials because the performance of the reclaimed slope will depend primarily on the shear strength of these materials. Laboratory testing was conducted on the Residual soil to assure that the properties, all materials involved in the stability of the reclaimed slope, were rigorously determined. The sources and analyses used to develop shear strength parameters for the geotechnical model are presented in the remainder of this section.

The moist (unsaturated) and saturated weights were set at the same value in the slope stability model for the bedrock units because the slope lies above the phreatic surface. Therefore, the slope stability model only considers moist unit weight, and the existing highwall is currently stable. The saturated unit weights of the soil materials were used because the moist unit weights were not directly determined by laboratory analysis. The saturated unit weights were calculated from the maximum dry densities determined by the Standard Proctor Compaction Tests (Appendix A). Using saturated unit weights is more conservative than using moist unit weights.

3.3.1 Bedrock Units

The shear strength parameters for the bedrock units, including the engineering lithologies termed coal, interbedded sandstone and siltstone, and basal sandstone, were derived from testing conducted by the U.S. Bureau of Mines (USBM) on lithologies from the nearby Sunnyside Mine (Schriebner 1979). Schriebner (1979) tested sandstones, siltstones, and coal in triaxial compression. The values for coal were taken directly from the one set of values presented by Schriebner (1979).

Schriebner (1979) also presented three sets of data for siltstones and two sets of data for sandstones. These five sets of data were averaged to produce mean values for the relevant parameters. The mean laboratory test values from Schriebner (1979) for Unconfined Compressive Strength (UCS), Internal Friction Angle (φ), Cohesion (c), along with estimated values for RQD and joint spacing, were used to derive estimated rock mass strengths, based on the Hoek and Brown (1980) failure criterion method to convert laboratory rock test values to practical *in situ* rock mass strengths, expressed in terms of the Mohr-Coloumb Failure Criterion. This conversion is prudent because test results on laboratory specimens are typically high because they do not reflect the reduced strength of the rock mass that is due to the presence of discontinuities and other effects of scale. The resultant values are friction angle of 45 degrees and cohesion of 111,168 psf.

3.3.2 Soils

The engineering lithologies included in the soils category are Residual soil, Topsoil, and Backfill. The shear strength values for these units are based on the mean of values generated by laboratory testing conducted for Revision No 4. These values were determined by direct shear tests on samples remolded to 90% of optimum dry density and +2% above optimum moisture content, as determined by Standard Proctor Compaction specifications (Appendix A).

3.3.3 Geosynthetics

The geosynthetic products used in this slope design include a composite drain, a filter fabric, and geogrid. The composite drain will be used to drain any seeps. The composite drain is comprised of an open-weave HDPE grid to transmit water, backed with a filter fabric to permit water to enter but prevent the intrusion of fine soil particles. A filter fabric is also recommended between the rockfill and the overlying Backfill. The filter fabric modeled for this evaluation is a non-woven geotextile. Geogrid will be used to reinforce the surficial rooting zone.

The shear strengths of the geosynthetic products were determined by consultation with Tensar, which is the manufacturer of the specified geosynthetic products. The minimum shear strength parameters for composite drain and filter fabric, as reported by Tensar, are a friction angle of 18 degrees and zero cohesion. The shear strength of the geogrid/soil interaction was determined by Tensar.

3.3.4 Backfill Material

Laboratory testing was conducted on samples of the Backfill material. The tests were designed to rigorously characterize the material and generate shear strength values. The raw direct shear test data have been corrected by AAI for changing area during the direct shear test. Shear stress, normal stress, and displacement are measured during direct shear testing. Normal stress is a function of normal load and the area of the sample in shear at any given point in time. The effectve area of a direct shear test decreases as shearing progresses. Stress is defined as force divided by area. Therefore, the normal stress changes as the effective area changes, and accurate direct shear test values are only obtained when area-correction is applied. Table 3 is a summary of laboratory test results for the Backfill material. The raw laboratory data and the area correction worksheets are presented in Appendix A.

Table 3. Summary of Laboratory Testing Results on Backfill Material

Test	ASTM Designation	Results
Direct Shear (large scale, normal loads = 25, 50, and 75 psi)	ASTM D3080 (12 by 12-inch shear box)	Post-peak friction angle (φ) = 54 degrees Cohesion (c) = 1877 psf
Moisture Content	ASTM D2216	0.9%
USCS classification	ASTM D2487	GM (silty gravel with sand)
Mechanical Analysis - Sieve Test Data	ASTM D422	See grain size curve, Appendix A
Atterberg Limits	ASTM D431s8	Liquid limit = non-plastic Plastic limit = non-plastic Plasticity index = non-plastic
Standard Proctor Compaction Test	ASTM D698 C	Optimum Density = 138 pcf Optimum Moisture Content = 8.9%

The results of the laboratory analyses indicate that the Backfill material has a Unified Soil Classification System (USCS) classification of GM (silty gravel with sand). The material is non-plastic, as determined by Atterberg Limits testing. The non-plastic determination is consistent with the USCS classification. A Standard Proctor Compaction test was conducted on the Backfill material to determine optimum moisture content and density for placement during backfilling.

Large-scale (12 by 12-inch) direct shear tests were conducted to determine Mohr-Coulomb strength criteria for the material. Three tests were conducted at normal loads of 20, 30, and 40 psi. The sample material was compacted in the shear box at 2% greater than the optimum moisture content (11%) and 90% of optimum density (120 pcf). The results of the three-point direct shear test program indicates that the post-peak friction angle is 54 degrees and the cohesion is 1877 psf.

Residual friction angle values are not typical for direct shear tests on coarse-grained material because the coarse particles tend to rotate, causing dilation and strain hardening, such that post-peak values are the most representative of actual field conditions. During a direct shear test, the upper and lower shear boxes are translated relative to one another at several predetermined normal loads. The shear forces are necessary to cause initial and post-peak displacement measured during the test. A plot of shear displacement versus shear force is recorded during the test. For most materials, a peak shear force is observed, which represents the force required to initiate shearing. The post-peak behavior of the shear-force-versus-displacement curve reflects the behavior of the material after shearing has been initiated. Fine-grained materials, such as clays, typically undergo a reduction in shear strength following peak shear strength. A post-peak shear strength measured for such a test would be termed the "residual shear strength", and is represented by the nearly linear portion of the displacement-versus-shear-strength curve (Appendix A). In the case of the Backfill material for this evaluation, there was adequate coarse-grained material present so that at the low normal loads used for these tests, the material continued to gain strength after shearing had begun. This was probably because the larger particles in the material were rotating, causing the larger particles to act as keys and increase shearing resistance. Low normal loads were chosen to simulate the relatively small amount of overburden that will be present above a hypothetical shear plane. Post-peak shear strengths are typically used in slope evaluation because the conservative assumption is made that the material has already undergone peak shearing.

4.0 DESIGN RECOMMENDATIONS

The design criteria for the proposed reclaimed portal cut slope that were considered for this evaluation include:

- Slope angle reduction
- Minimum reclaimed slope performance safety factors of 1.3_{static} and $1.1_{pseudostatic}$
- Maintaining the toe of the reclaimed slope at the current toe of the lower bench
- Preventing excess pore water pressure development
- Revegetation rate of at least 70%
- Aesthetically blended appearance

4.1 Reclaimed Slope Design

The toe of the slope Backfill will be maintained at the toe of the lower bench, as shown on Figure 4. This will result in a reclaimed slope face angle of 40 degrees, which is consistent with the lower portions of the natural valley slopes in the canyon occupied by the West Ridge Mine.

Two drainage components have been incorporated in the slope design. Although no seeps have been observed on the portal cut rock face by West Ridge personnel, a geosynthetic composite drain will be placed against the portal cut slope face to collect water from any seeps that may occur and prevent excess pore water pressures from developing in the slope. The composite drain will be placed the full vertical height of the slope above the upper bench, cover the surface of the upper bench, and terminate in a rockfill toe drain on the lower bench at the base of the slope. The composite drain will cover at least 30% of the portal cut slope and will be evenly distributed across the slope. West Ridge personnel will document the water condition of the highwall during mining operations by establishing photo-stations. Photo-stations are known points from which a series of photographs are taken over time, of the same scene. The locations of any seeps that may occur will be documented so coverage of those areas of the slope by the composite drain can be assured. Photographs will be taken during the second and third quarters of every groundwater monitoring year during the life of the mine.

The drainage layer has been incorporated to prevent the build-up of excess pore water pressures. Excess pore water pressures oppose the stability-enhancing normal load imparted by the Backfill material and can significantly impact slope stability. This conservative approach was taken because, although no seeps have been observed on the existing slope, there are no historical data available that would allow trends in groundwater behavior and occurrence to be established for unusually hot or dry periods. Although the drainage layer results in a slight decrease in shear strength, the design for safety factor is still met.

A drainage layer of clean, angular rockfill, having the gradation specifications listed in Table 4, will be placed at the base of the toe of the slope, between the base of the upper bench and the toe of the slope, to a maximum thickness of 2 ft. The exposed face of the rockfill will be wrapped with a biaxial geogrid-type material, such as Tensar BX1100 or Engineer approval equivalent, to prevent raveling. The geogrid will be imbedded to a horizontal depth of at least 9.8 ft at the top and bottom of the rockfill layer according to the manufacturer's recommendation. The

Table 4. Suggested Gradation Specifications of Rockfill Material

Particle Size	Allowable Range of Particle Sizes (%)
< 12-inch	100
< 9-inch	100
< 6-inch	80–100
< 3-inch	50–80
< ¾-inch	15–50
< No. 4 sieve	0–20
< No. 30 sieve	0–5
< No. 200 sieve	0–1

composite drain will terminate in the rockfill layer, such that any water reaching the composite drain will drain to the rockfill toe drain and exit the base of the slope through the face of the rockfill drain. A non-woven, geotextile filter fabric will be placed between the top of the rockfill drain and the overlying soil Backfill to prevent plugging of the drain by the infiltration of fine soil particles into the rockfill drain.

The Backfill material will be placed in loose lifts with a maximum thickness of 6 inches. Hand-operated compaction equipment will be used near the slope face to assure compaction.

A separation of Backfill from the *in situ* slope, due to compaction and settlement, is often observed at the crest of a backfilled slope. The potential for this occurrence will be minimized by careful compaction at the crest, overlapping of Backfill material onto *in situ* material, and limited blending of surficial materials. Nonetheless, any crack that may occur is expected to develop during the reclamation monitoring period, and likely within a few month's time. Any such crack at the crest of the slope will be backfilled with suitable material, to prohibit infiltration of surface water, and then regraded to promote drainage. Post-construction settlement is expected to be minimal, on the order of 1% or less, because of the rigorous compaction specifications that have been specified during backfill placement.

A 4-ft-thick rooting zone will comprise the surficial layer of the slope, to provide an optimum medium for plant growth. The rooting zone will consist of 3 ft of Backfill material overlain by 1ft of Topsoil. West Ridge has an adequate volume of stockpiled Topsoil and Backfill material for the highwall reclamation application. The soils placed in the rooting zone will not receive mechanical compaction, to assure optimum rooting conditions. The slope face will be stabilized using a geogrid material to maintain stability without mechanical compaction. Geogrid-stabilized soil slopes are commonly constructed at 70-degree face angles. The geogrid will have an embedment depth of 9.8 ft, measured from the slope face, which will span the interface between the compacted structural fill, and the non-compacted rooting zone materials. The geogrid layers will be vertically spaced at 1.5-ft intervals. Figure 5 is a conceptual drawing showing stability and revegetation components, which are not to scale on the drawing. Containerized shrubs and trees will be planted in pockets constructed on the slope. Boulders will also be placed in pockets on the slope.

The slope face will be constructed with a roughened surface to promote revegetation and aesthetically blend with natural slopes in the area. Slope roughening promotes revegetation by creating pockets that trap sediment and collect moisture, resulting in enhanced plant growth and aiding in natural reseeding. Roughening also increases resistance to erosion. The slope will be roughened using a combination of backhoe and hand surface work. Planar surfaces will be roughened to a depth of between 12 and 18 inches and a width equal to the width of the backhoe bucket in use, typically 2 to 4 ft. Areas that are not accessible by a backhoe will be roughened by hand work. Slope surface roughening will be accomplished in a random and overlapping pattern, such that there are no continuous planar surfaces that would allow erosion, including slope wash from overland flow and rill formation. The boulders that will be placed on the slope will further increase surface roughening and provide additional erosion protection. Additionally, smaller rocks (6-inch minus) will also be scattered around the surface of the reclaimed slope. The irregular nature of the slope, along with the rocks and boulders, will provide "micro-habitats" to enhance the establishment of native plant species on the reclaimed surface. These micro-habitats will provide shade, pockets for moisture retention, variability in exposures to the sun, and other environmental variables that will enhance natural re-seeding, and future species diversity.

The following sequence will be used to construct the rooting zone slope face. A course of geogrid will be placed on the underlying course. Backfill material will be placed on top of the geogrid, moisture-conditioned, and compacted in 6-inch-thick, or less, lifts to within 4 ft (laterally) of the slope face. A 3-ft-wide layer of non-compacted Backfill material will be placed between the compacted Backfill material and the slope face, followed by a 1-ft-wide non-compacted Topsoil layer. The process is then repeated.

The geogrid is considered a permanent construction material, and is commonly used in civil applications, particularly roadcuts. The long-term stability of the slope face will be assured by the geogrid-reinforced construction. Erosion will be controlled by the roughened slope, boulders, plantings, and a bonded fiber matrix mulch material, as discussed in the following section.

4.2 Revegetation Plan

Following final seedbed preparations, including slope roughening, the slope will be seeded, fertilized, and mulched using hydroseeding equipment. The fertilizer will be applied in the first application, followed by another application that contains seed and mulch. Following these treatments, containerized plants will also be planted on the reclaimed slope. Figure 6 shows typical applications of the revegetation components.

Fertilization

Use of commercial chemical fertilizers initially produces a sharp upward spike in nutrients, which drops off very quickly. This often encourages weed species growth that can out-compete more desirable native plant species.

Following final seedbed preparations, the slope will be broadcast with an organic amendment at the rate of 1500 pounds per acre. The organic amendment used will be a fertilizer called Biosol® 6-3-1 (or a similar product). Biosol® 6-3-1 is an organic treatment that produces very slow releasing nutrients, while encouraging microbial activity (microorganisms). Use of this product or other slow-releasing organic amendments have been especially favorable on other reclamation projects with harsh conditions such as steep slope stabilization (Claassen and Hogan 1998; Erosion Control Journal 1997; Rohlman 1993). This product can be applied using either hydroseeding equipment or by hand broadcasting to spread it on the slope.

Seeding

The reclaimed portal slope will be hydroseeded with the seed mixture shown in Table 5. This is the same species mixture that has been approved for application in other Douglas Fir/Rocky Mountain Juniper communities on the mine site at the time of final reclamation.

Mulch

The slope will be mulched with a bonded fiber matrix material such as EcoAegis™ or SoilGuard® at the rate of 3,500 lbs/acre (or as recommended by the manufacturer's specifications). For this site, this material will conform to the soil much better than erosion control matting. By

Table 5. Revegetation Seed Mixture for the Portal Slope at the West Ridge Project

Scientific Name	Common Name	PLS # / AC*
TREES/SHRUBS		
*Amelanchier utahensis***	Serviceberry	2.0
Artemisia tridentata var. vaseyana	Big Sagebrush	0.2
*Cercocarpus ledifolius***	Mountain Mahogany	2.0
*Pseudotsuga menziesii****	Douglas Fir	1.0
*Symphoricarpos oreophilus***	Snowberry	0.5
FORBS		
Achillea millefolium	Yarrow	0.1
Aster engelmannii	Engelman Aster	0.5
Hedysarum boreale	Northern Sweetvetch	1.5
Linum lewisii	Lewis Flax	1.0
Penstemon eatonii	Eaton's Penstemon	0.5
GRASSES		
Elymus lanceolatus	Thickspike Wheatgrass	2.0
Elymus spicatus	Bluebunch Wheatgrass	3.0
Poa fendleriana	Muttongrass	0.3
Poa secunda	Sandberg's Bluegrass	0.4
Stipa comata	Needle-and-Thread	2.0
Stipa hymenoides	Indian Ricegrass	2.0
TOTAL		**19.0**

* Rates based on drill seeding pure live seed (PLS). The rate would be doubled if the seeding method employed is surface broadcasted.

** Containerized plants of at least three of these species will be planted at equal proportions, for a total rate of 2,500 plants/acre.

*** Large trees (5 to 6 ft) will be transplanted at a rate of 145 trees per acre (spaced irregularly).

design, the final seedbed surface will be uneven and rough. If typical erosion control mat were used here, it could loose contact with the soil in these uneven areas, causing a "tent" effect. Erosional rills and gullies could form on the soil surface under these "tents." The bonded fiber matrix product will also be less obtrusive to wildlife that may pass over the slope. Other mulch materials could cause injury to wildlife or could be damaged by wildlife.

Containerized Plants

Containerized woody plant seedlings will be planted at approximately equal portions, for at least three species, at the total rate of 2,500 plants per acre. These plants will be placed in a semi-regular, natural-looking fashion in an attempt to enhance slope stability equally over the entire slope without giving the appearance of an "orchard" or other unnatural community scenarios.

Large Trees

Large trees (5 to 6 ft in height), such as Douglas Fir, will be planted at a rate of 145 trees per acre and spaced irregularly on the slope.

The bonded fiber matrix products mentioned above are intended to treat steep slopes and to endure harsh conditions such as heavy rains and snows, giving plants the time necessary to become established.

Diverter Logs (optional)

As mentioned, the proposed surface of the final seedbed will be "roughened" or very uneven and may not need them, but it will remain an option to regularly place "diverter logs" parallel with the contours of the slope. The logs have been successful elsewhere for enhancing slope stability of burned and reclaimed areas (Oertel 1998). These logs can be natural logs cut from trees such as Lodgepole Pine or manufactured such as those called Excelsior® logs.

Examples of Steep Reclaimed Slopes

The following are examples of successful revegetation that have been accomplished on slopes as steep as 40 degrees.

EXAMPLE 1: Mesa Verde National Park

The following is a good example of reclamation of steep slopes:

Paschke, M.W., C. DeLeo, and E.F. Redente (2000), "Revegetation of Roadcut Slopes in Mesa Verde National Park, USA," Restoration Ecology, 8(3):276–282.

Revegetation of the following slope angles and aspects have been studied:

Roadcut Sites

A. 40 degrees, Aspect: S

B. 34 degrees, Aspect: NW

C. 31 to 35 degrees, Aspect: S

Revegetation Techniques – In this study, the following reclamation techniques were employed:

A. Fertilization (Biosol®)

B. Mulching (Excelsior® blanket)

C. Soil Pitting

D. Polyacrylamide Polymer Amendment (Western Polyacrylamide, Inc.)

Although cover results of the revegetation in the above reference is *not* 70%, reclaimed slopes are approaching "background" conditions, or the native undisturbed plant communities in the area.

EXAMPLE 2: Pacificorp's Cottonwood Fan Portal Area

Pacificorp's Reclaimed Slope at the Cottonwood Fan Portal Area is a good example of a steep slope that has been reclaimed successfully. Slope angles in many areas of this slope approached 35 to 40 degrees. Total living cover is nearly 50%, with a woody species density of 3,400 individuals per acre (Mt. Nebo).

EXAMPLE 3: Lost Trail Pass

Revegetation cut slopes at Lost Trail Pass, located on Highway 93 between Hamilton, Montana, and Salmon, Idaho, have slopes as steep as 40 degrees. Living cover and woody species density have significantly increased over time on these slopes. Elevation of this area was approximately 7,000 ft. The project was administered by USDA Forest Service and funded by Federal Highway Administration. The construction work was done by Bitterroot Restoration, Montana (Mt. Nebo).

5.0 SLOPE STABILITY ANALYSES

The stability analyses conducted for this evaluation indicate that the recommended slope design is expected to meet the established stability criteria. The objective of the slope stability evaluation was to model and analyze reasonable modes of slope failure for static and pseudostatic (earthquake) conditions. The slope failure modes that were evaluated included:

- The current geometry; static and pseudostatic
- Reclaimed backfilled slope without the composite drain; rotational failure surface; static and pseudostatic
- Reclaimed backfilled slope with the composite drain; rotational failure surface; static and pseudostatic
- Reclaimed backfilled slope with the composite drain; failure surface at geosynthetic/backfill interface; static and pseudostatic
- Surficial stability analysis of geogrid-reinforced slope face

The commercially available computer software XSTABL was used to compete all slope stability analyses, except the surficial stability analysis incorporating geogrid, which was completed by Tensar using Tensar proprietary software.

Pseudostatic stability analyses were conducted to simulate earthquake loading for all global stability analyses. A coefficient of horizontal acceleration of 0.07g with no coefficient of vertical acceleration was used in all pseudostatic analyses. The value for horizontal acceleration was obtained from the U.S. Geological Survey (USGS) Open-file Report No. 82-1033 (Algermissen et al. 1982), which is an industry-standard reference for pseudostatic analyses of slopes. The value of 0.07g is the horizontal acceleration having a 90% probability of exceedance within a 250-year period.

Bishop's Method (of Analysis) was used to conduct all initial searches for rotational failure surfaces. Bishop's Method is a force equilibrium routine. Every critical surface identified by Bishop's Method was subsequently analyzed using the more rigorous Spencer's Method (of Analysis) that considers force and moment equilibrium. In all of the rotational surface analyses, the safety factor did not vary significantly between Bishop's Method and Spencer's Method. The plane shear analysis of the composite drain/backfill interface was analyzed using Spencer's Method because the failure surface was specified. All critical slope stability model output files are included in Appendix B.

5.1 Evaluation of the Existing Portal Slope

The stability of the current geometry of the portal cut slope was evaluated to assure that the current configuration is expected to be stable. Rotational failure surfaces were analyzed because there does not appear to be a potential for failure along geologic structure because the dips of structures are primarily sub-parallel to the slope face.

The results of these analyses are shown on Figure 7. As expected, safety factors are very high for the current slope configuration. XSTABL returned safety factors of 9.4 for the static case and 8.7 for the pseudostatic case.

5.2 Evaluation of Backfilled Slope

The backfilled slope was modeled with and without the composite drain because the drain material will only need to cover 30% of the current slope face to effectively drain any seeps, and will be deployed such that complete vertical sections will either have or lack composite drain material.

The composite drain material represents lower shear strengths than the non-covered surfaces. The backfilled slope with the composite drain was analyzed for two failure modes: rotational and sliding along the geosynthetic/soil interface.

The stability analyses conducted for rotational failure primarily through the Backfill material, without the composite drain, indicate stable conditions. The resulting safety factors are static safety factor of 3.6 and a pseudostatic safety factor of 3.3. The results of these analyses are presented on Figure 8.

The stability analyses conducted for rotational failure primarily through the Backfill material, with the composite drain in place, indicate stable conditions. The resulting safety factors are static safety factor of 2.6 and a pseudostatic safety factor of 2.5. The results of these analyses are presented on Figure 9.

The stability analyses conducted for plane shear failure at the composite drain/backfill interface also indicates stable conditions. The resulting static safety factor is 1.3, and the resulting pseudostatic safety factor is 1.2. The results of these analyses are presented on Figure 10.

5.3 Evaluation of Surficial Stability

The stability of the 4-ft-thick surficial, uncompacted rooting zone was evaluated by Tensar using proprietary software. The internal friction angle used for the analysis was 39 degrees. The cohesion value was reduced from 1,700 psf to 50 psf to reflect the uncompacted nature of the rooting zone fill. The geogrid embedment depth used was 9.8 ft, measured horizontally from the slope face. This depth will span the interface between the compacted fill and the uncompacted fill. This interface is expected to be the plane of weakness where shearing would occur, if the geogrid reinforcement were not in place. The vertical spacing of the geogrid layers will be 1.5 ft. A saturation depth of 4 ft was used in the analysis to simulate saturated conditions. The results of the evaluation indicate stable conditions. The safety factor against sliding along the compacted fill/uncompacted fill interface is 1.3 for the static case. Pseudostatic analyses are not inherent in the Tensar software used for this analysis. Pseudostatic analyses are not required by DOGM. Details of the Tensar analysis are presented in Appendix C.

6.0 SLOPE BACKFILL CONSTRUCTION METHODS AND EQUIPMENT

Prior to backfilling, the existing Backfill above the portals will be excavated to reveal the portal support materials. The steel sets and batter material will be removed from the portals. The fill in the portal cuts will be brought up to the level of the existing bedrock bench as the overall area is backfilled.

Grade stakes will be placed at the toe of the slope by survey methods to define the area of fill placement. Construction equipment will change from larger equipment to smaller equipment (even hand-operated equipment) as the slope height increases and the footprint decreases. All construction activities will be supervised by a Registered Professional Engineer (Engineer) with experience in steep, reinforced-slope construction. Compaction and moisture content specifications will be verified by the Engineer, or his qualified field representative, using a properly and recently calibrated nuclear density gage. Specifications will be based on laboratory Standard Proctor test results (Appendix A). Field Standard Proctor tests will also be conducted to verify that the fill is capable of meeting laboratory specifications.

Prior to placing the rockfill toe drain, a course of geogrid (Tensar BX1100 or Engineer approval equivalent) will be placed such that a 9.8-ft embedment depth is created. The 2-ft-thick basal layer of rockfill that comprises the toe drain will be placed using a front-end loader (Caterpillar 950G or Engineer approval equivalent). The geogrid will be wrapped around the face of the rockfill and embedded 9.8 ft along the top of the rockfill layer. The geotextile filter fabric (Evergreen Technologies Inc. DC4200 or Engineer approval equivalent) will be hand-placed over the geogrid and rockfill layer. The first course of Backfill material will be placed over the rockfill, with the exception of the 1-ft-thick (normal to the slope) Topsoil layer.

Placement of Backfill material will be accomplished by compacting the material in 6-inch thick (or less) lifts to meet compaction specifications of 90% of Standard Proctor test results, and ±2% of optimum moisture content. Lifts may be continuous across the base of the fill area, including the excavated portals, or may be sequenced at the discretion of the contractor, as long as sequencing results in uniform compaction methods across each lift. A front-end loader (Caterpillar 950G or Engineer approval equivalent) will place the Backfill material in loose lifts in the lower reaches of the slope. As the slope height increases and the footprint decreases, skid-steer loaders, such as the Caterpillar 216, Bobcat 463 or Engineer approval equivalent, will be used to place fill material. The lifts will be graded to a planar configuration using a Caterpillar 12H motor grader or Engineer approval equivalent. When the footprint becomes too small for the motor grader, lifts may be graded by careful bucket back-dragging in conjunction with hand labor, as determined by the contractor. The fill material will be moisture conditioned using a water truck (any suitable model) fitted with a water cannon, such that the fill can be moisture conditioned without the water truck traversing the fill.

Each lift will then be compacted using a sheep's foot-type soil compactor. A Caterpillar 815F, or Engineer approval equivalent, will be used in the lower sections of the fill. A smaller Caterpillar CP433E, or Engineer approval equivalent, will be used in the higher sections of the slope, as determined by the contractor. Hand-operated compaction equipment will be used in the upper reaches of the slope, as determined by the contractor, such as a Wacker RT 560 Vibratory Trench Compactor, or Engineer approval equivalent. Following compaction, each lift will be smooth-graded using the Caterpillar 12H motor grader (or Engineer approval equivalent), where slope height and footprint allow, and using skid-steer loaders and hand labor where the footprint is too small for the motor grader. Care will be taken near the crest of the slope to assure that the fill is well compacted against the rock highwall.

The surficial rooting zone material will be placed following placement of three 6-inch lifts of compacted Backfill. This will consist of a 3-ft-wide layer of uncompacted Backfill material placed adjacent to the compacted fill, and a 1-ft-wide layer of uncompacted Topsoil placed at the slope face. These layers will be placed in 1.5-ft-thick lifts, in accordance with the specified vertical separation between geogrid reinforcement layers. The rooting zone materials may be placed by a front-end loader in the lower reaches of the Backfill. An excavator (Caterpillar 307C, 312C, or Engineer approval equivalent) will be used to place the uncompacted material as the slope height increases and the footprint decreases.

Once a sequence of three lifts (1.5 ft thick) has passed inspection by the Engineer, a course of geogrid will be placed. A 10-ft-wide (9.8-ft effective width) roll (Tensar BX1100 or Engineer approval equivalent) will be placed across the slope such that the outer edge is coincident with the slope face. The geogrid will be staked in place. After placement of the geogrid, the slope will be ready for the next soil lift, and the process will be repeated. This width of geogrid will result in about 6 ft of the geogrid being embedded in compacted Backfill material, and about 4 ft overlying the uncompacted fill.

Starting with the first soil lift above the rockfill toe drain, geosynthetic composite drains (JDR Enterprises, Inc. J-Drain 400, or Engineer approval equivalent) will be evenly spaced, vertically on the highwall face such that 30% of the face is covered by the drains. The drains will terminate in the rockfill toe drain, and will continue vertically to the crest of the slope. Any areas of the highwall where seeps were observed will be covered with additional drains.

The slope face will be roughened using an excavator (Caterpillar 307C, 312C, or Engineer approval equivalent), as described in "The Practical Guide to Reclamation in Utah" (Utah Division of Oil, Gas, and Mining 2001). Boulders will be placed on the slope using the excavator. Trees and containerized shrubs will be hand-planted on the slope. Mulching and hydroseeding will be applied, according to Section 4 of this document.

7.0 CONCLUSIONS

A reclaimed slope design was developed by AAI and Mt. Nebo that satisfies the requirements of slope stability, vegetation density, and aesthetic blending with surroundings. All of the modeled failure scenarios of the reclaimed slope have safety factors that were significantly greater than the minimum slope stability requirements of a static safety factor of 1.3 and a pseudostatic safety factor of 1.1.

A geotechnical model was developed that represented the most critical slope geometry with respect to slope height and slope angle. Shear strength parameters were developed for the Backfill material, Topsoil, and Residual soil, based on a comprehensive laboratory testing program. Shear strength values for the other components of the slope were determined from previous investigations at the West Ridge Mine and from manufacturers' recommendations.

The reclaimed slope design is characterized by a backfilled slope with a face angle of 40 degrees. Surficial slope stability and revegetation will be optimized by a geosynthetically stabilized, non-compacted rooting zone. A geosynthetic composite drain will partially cover the existing highwall to prevent the build-up of positive pore water pressures. The composite drain will terminate in a rockfill toe drain. The face of the reclaimed slope will be roughened and irregular. Boulders and cobbles will be incorporated in the slope. The surface will be protected from erosion by a permanent erosion blanket. The slope will be revegetated with a seed mix and containerized plantings, including large fir trees of species that have been approved for use at the West Ridge Mine site.

The reclaimed slope is expected to maintain long-term stability. The irregular, roughened, revegetated, reclaimed slope surface is expected to blend with the natural setting of the canyon occupied by the West Ridge Mine.

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Principal and Vice-President

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Exp. 5/31/07

8.0 REFERENCES

Agapito Associates, Inc. (2002), "Revision No. 2: Stability Evaluation for the Proposed Reclaimed Slope at the Portal Excavation, West Ridge Mine," Report Prepared for West Ridge Resources, Inc., January.

Agapito Associates, Inc. (2001), "Revision No. 1: Stability Evaluation for the Proposed Reclaimed Slope at the Portal Excavation, West Ridge Mine," Report Prepared for West Ridge Resources, Inc., June.

Agapito Associates, Inc. (2001), "Stability Evaluation for the Proposed Reclaimed Slope at the Portal Excavation, West Ridge Mine," Report Prepared for West Ridge Resources, Inc., March.

Agapito Associates, Inc. (1998), "Stability Evaluation for Construction and Reclaimed Slopes, West Ridge Mine," Report Prepared for Andalex Resources, January.

Agapito Associates, Inc. (1997b), "Preliminary Gateroad Design and Pillar Sizing, West Ridge Project," Report Prepared for Andalex Resources, December.

Agapito Associates, Inc. (1997a), "Longwall Panel Orientation Study, West Ridge Project," Report Prepared for Andalex Resources, November.

Algermissen, S.T., D.M. Perkins, P.C. Thenhaus, S.L. Hanson, and B.L. Bender (1982), "Probabilistic Estimates of Maximum Acceleration and Velocity in Rock in the Contiguous United States," U.S. Geological Survey Open-File Report 82-1033.

Claassen, V.P. and M.P. Hogan (1998), "Generation of Water-stable Soil Aggregates for Improved Erosion Control and Revegetation Success," Soils and Biogeochemistry Section, Dept. of Land, Air and Water Resources, University of California, Davis, California.

Erosion Control Journal (1997), "Healing Broken Landscapes," Journal of the International Erosion Control Society, September/October.

Hoek, E. and E.T. Brown (1980), *Underground Excavations in Rock*, The Institution of Mining and Metallurgy, London.

Oertel, B. (1998), "Mesa Verde National Park Recovering from the 1996 Fire," Land and Water, Fort Dodge, Iowa, November/December.

RB&G Engineering Inc. (1999), "West Ridge Mine, Carbon County, Utah," Geotechnical Investigation Report to Dave Shaver, Andalex Resources, June.

Rohlman, E. (1993), "Payette National Forest Mine Reclamation Project Summary: 1992–1993," McCall Ranger District, McCall, Idaho.

Schriebner (1979), "Geology of the Single-Entry Project at Sunnyside Coal Mines #1 and #2, Sunnyside, Utah," USBM RI 8402.

State of Utah, Division of Oil, Gas and Mining (2001), "The Practical Guide to Reclamation in Utah," from the State of Utah web site, http://www.dogm.nr.state.ut.us.

Figure 1. Site Location Map

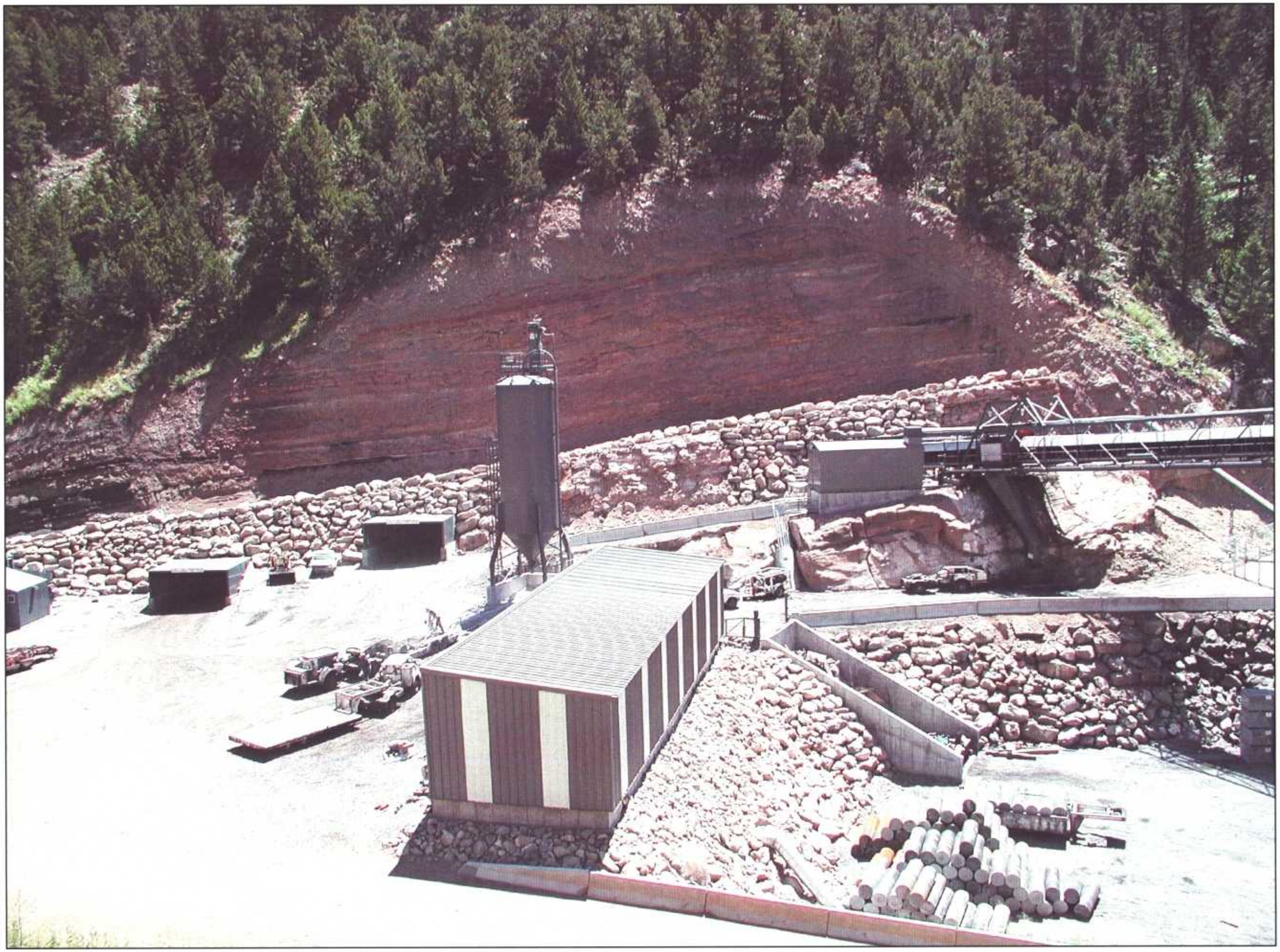

Figure 2. Photograph of Portal Cut Slope

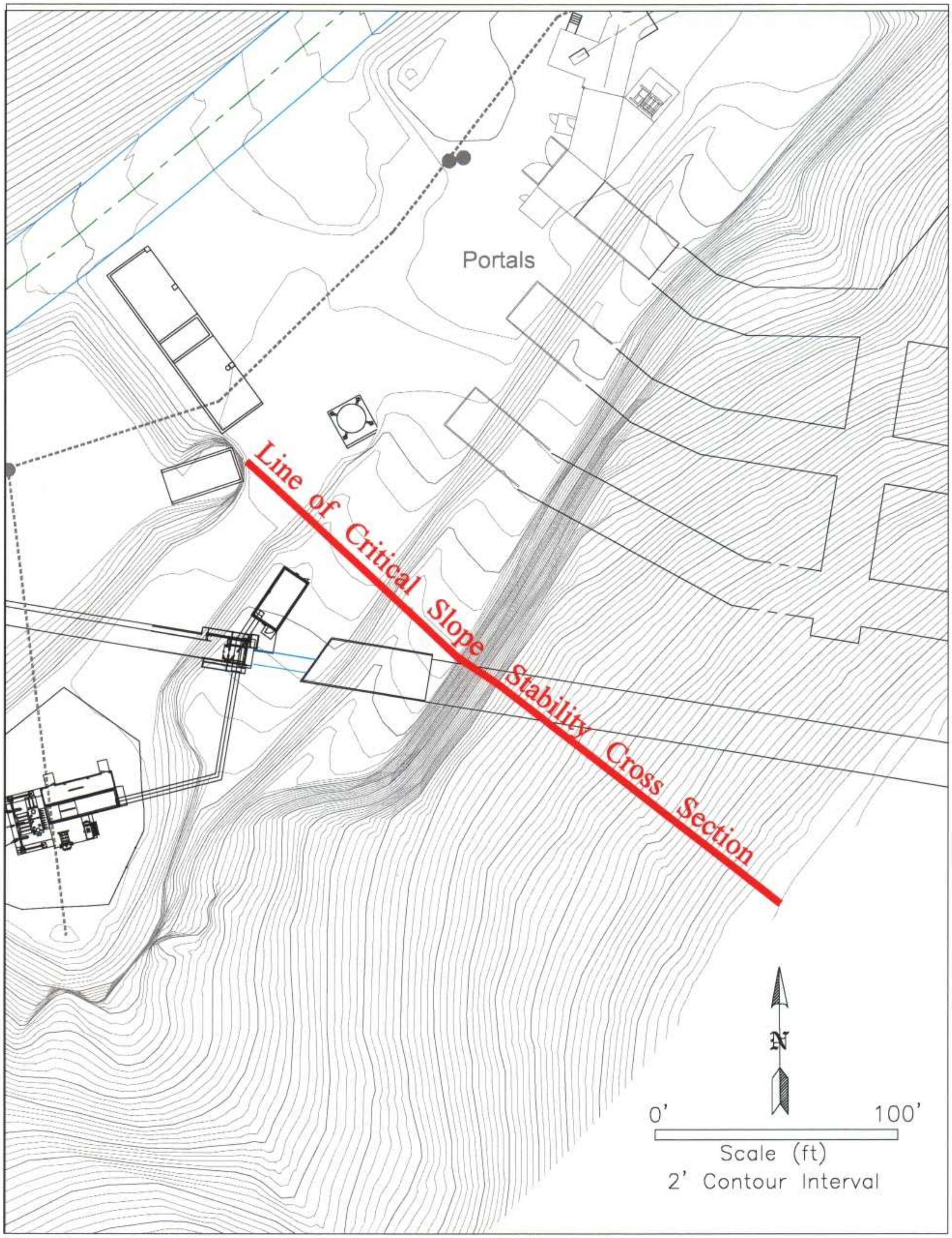

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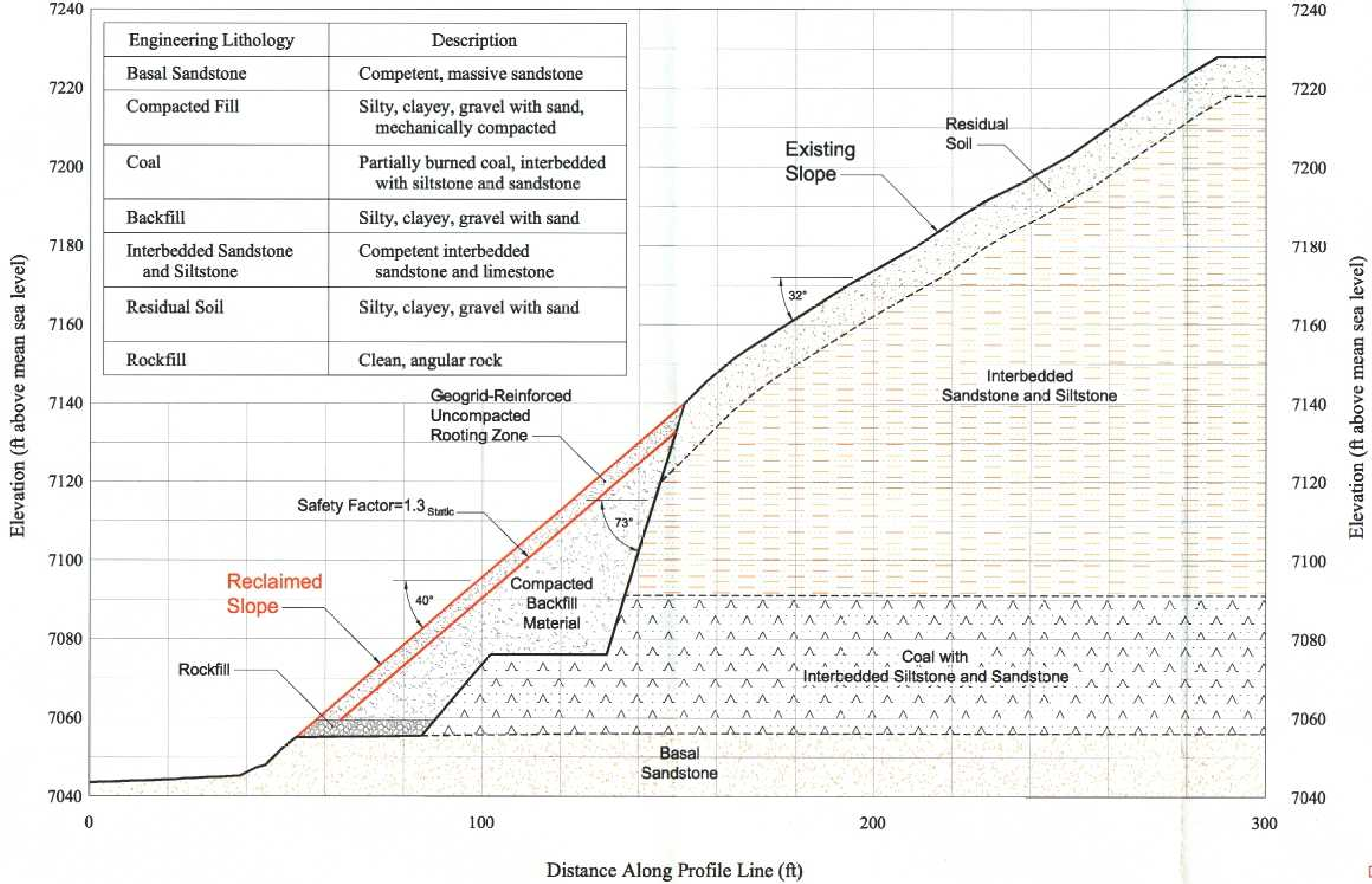
Figure 3. Location of Critical Slope Stability Cross Section



Engineering Lithology	Description
Basal Sandstone	Competent, massive sandstone
Compacted Fill	Silty, clayey, gravel with sand, mechanically compacted
Coal	Partially burned coal, interbedded with siltstone and sandstone
Backfill	Silty, clayey, gravel with sand
Interbedded Sandstone and Siltstone	Competent interbedded sandstone and limestone
Residual Soil	Silty, clayey, gravel with sand
Rockfill	Clean, angular rock

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460-3 Andalex [460-3 West Ridge Geotechnical Model 3-2003.dwg Layout Fig 4-Geotech Model]:rjl (3-11-2003)

Figure 4. Geotechnical Model for Portal Cut Slope

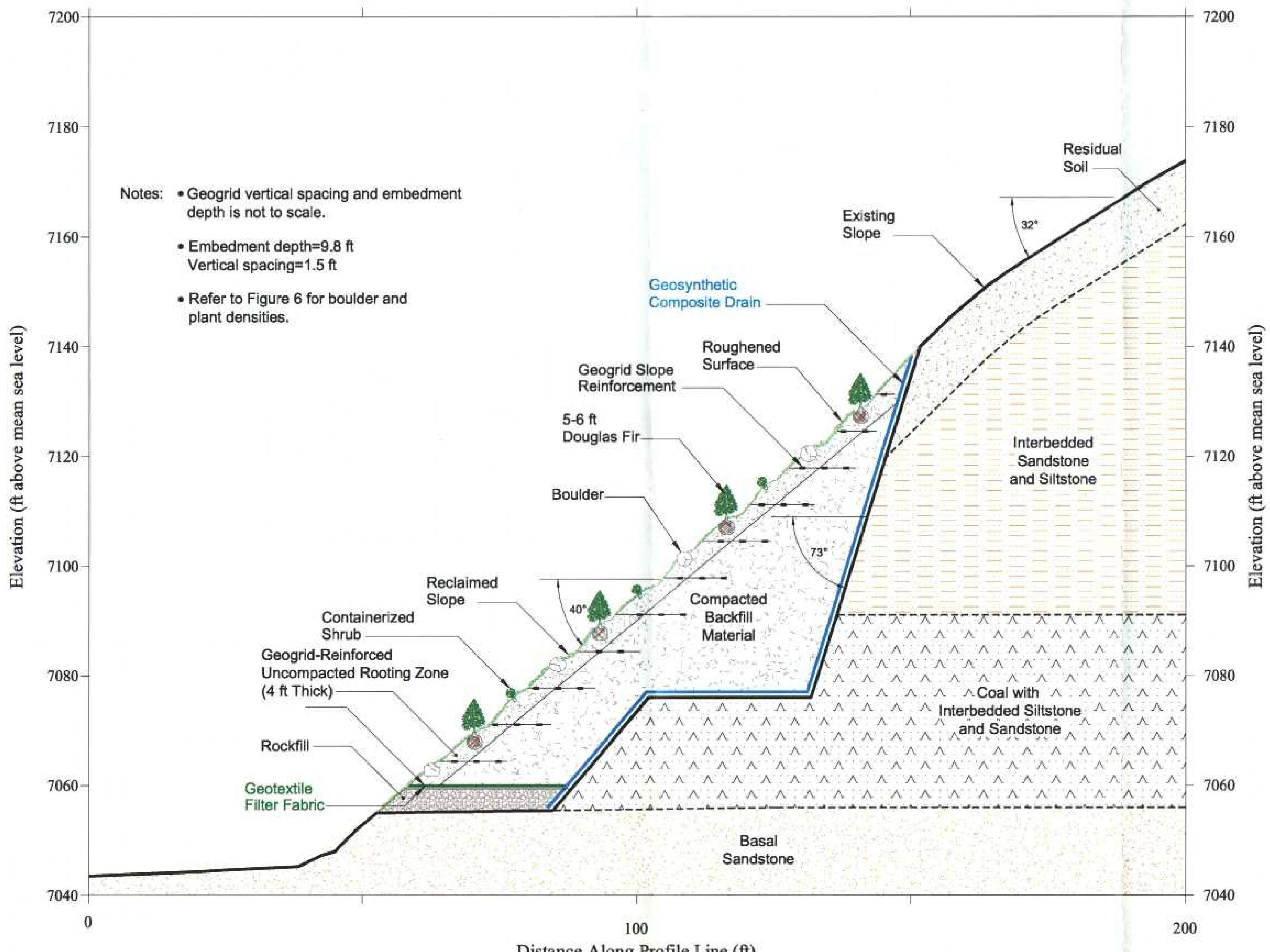

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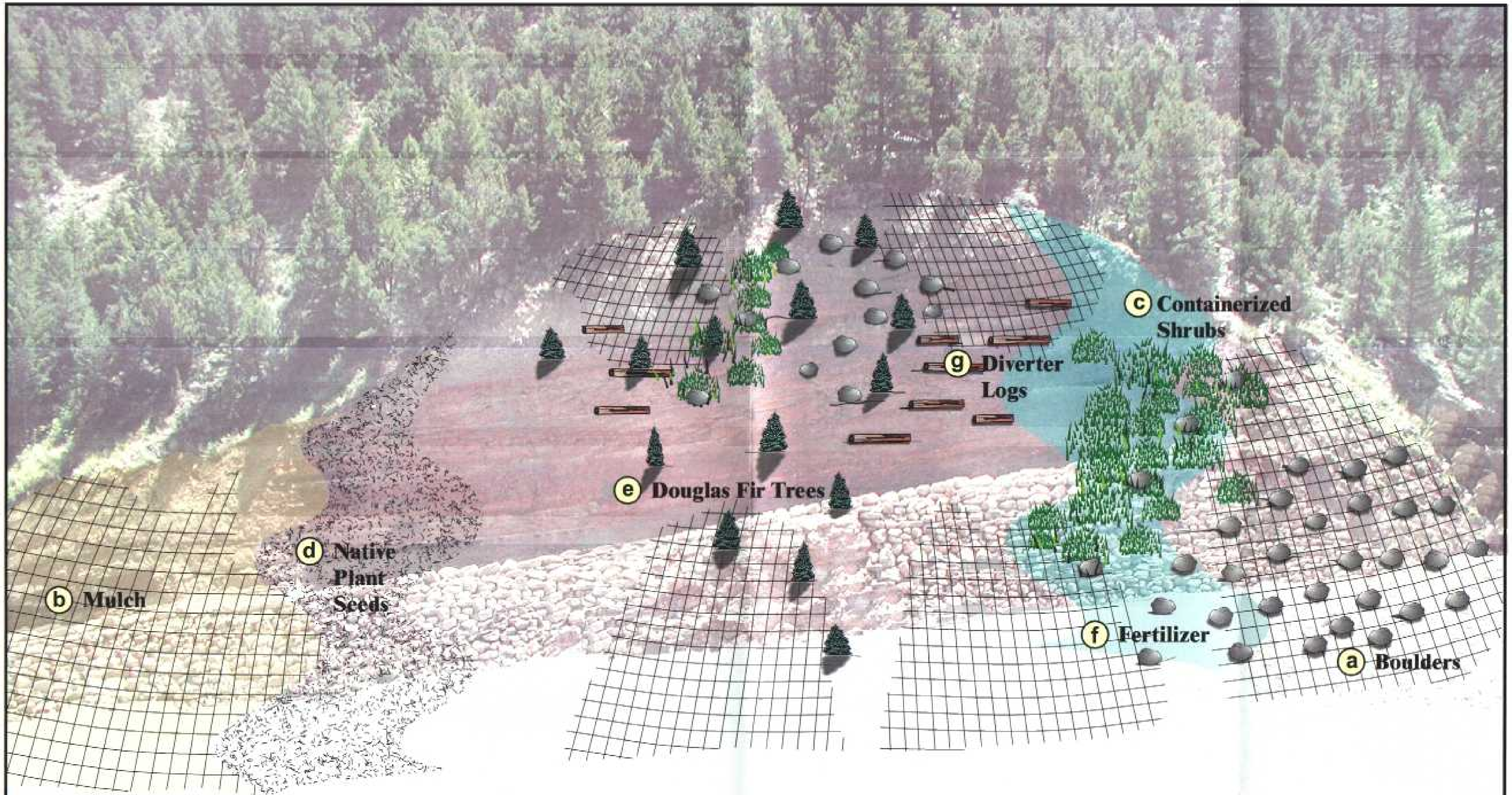
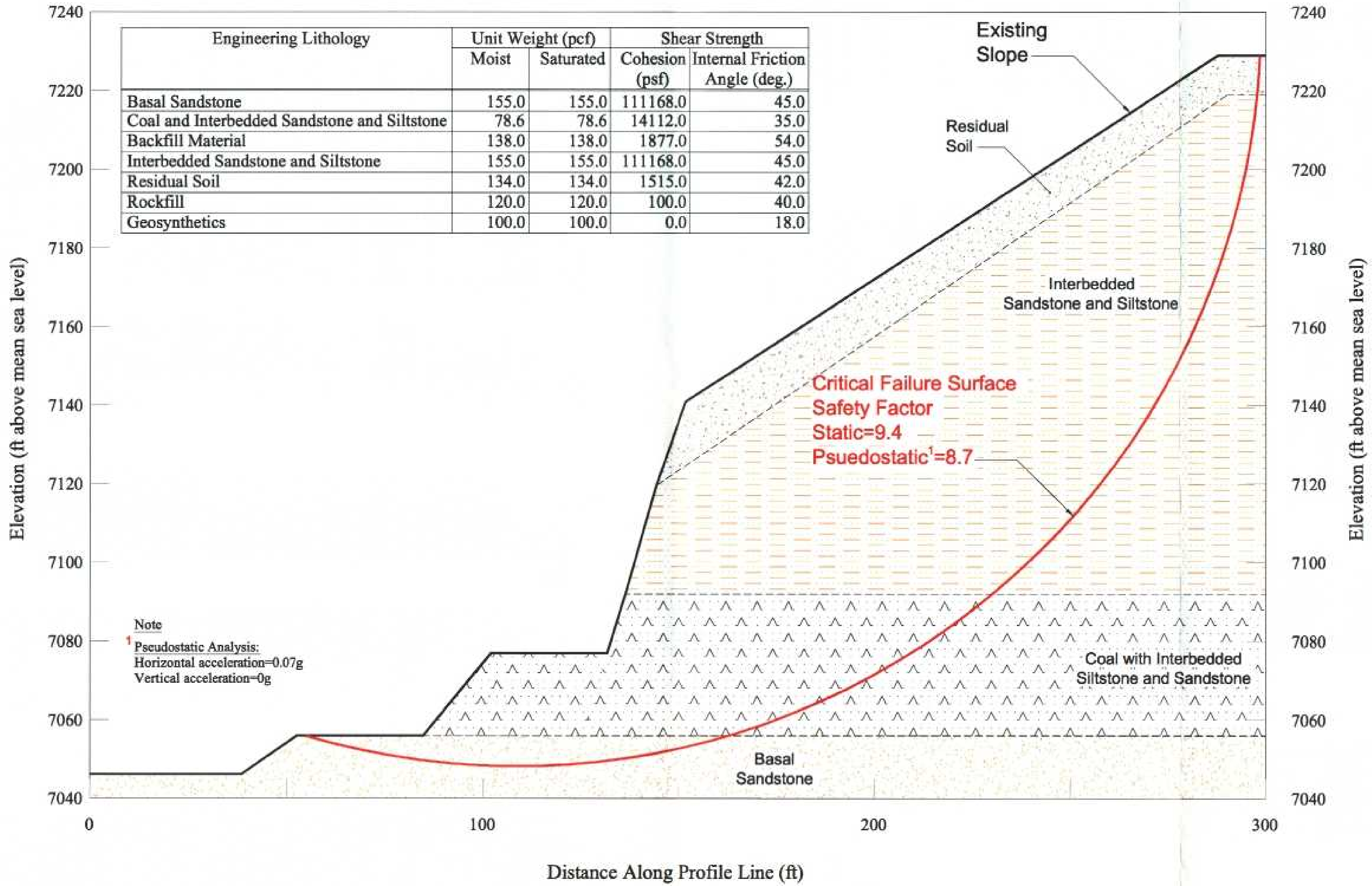
Figure 5. Conceptual Reclaimed Slope Profile



Explanation

- (a) Boulders placed over entire slope @ 1/100 ft^2 spacing
- (b) Entire slope mulched with Soilguard® or similar product @ 3500 lbs/acre
- (c) Containerized shrubs planted @ 2500 plants/acre over entire slope
- (d) Entire slope planted with native plant seed mix (see Table 5)
- (e) Entire slope planted with 5-6 ft high Douglas Fir trees @ 1/300 ft^2 spaced irregularly on slope
- (f) Entire slope fertilized with Biosoil® (6-3-1) or similar product @ 1500 lbs/acre
- (g) Diverter logs placed as needed (optional)
- Represents Reclaimed Slope Surface

Figure 6. Post-reclamation Slope Surface



Engineering Lithology	Unit Weight (pcf)		Shear Strength	
	Moist	Saturated	Cohesion (psf)	Internal Friction Angle (deg.)
Basal Sandstone	155.0	155.0	111168.0	45.0
Coal and Interbedded Sandstone and Siltstone	78.6	78.6	14112.0	35.0
Backfill Material	138.0	138.0	1877.0	54.0
Interbedded Sandstone and Siltstone	155.0	155.0	111168.0	45.0
Residual Soil	134.0	134.0	1515.0	42.0
Rockfill	120.0	120.0	100.0	40.0
Geosynthetics	100.0	100.0	0.0	18.0

Note
[1] Pseudostatic Analysis:
Horizontal acceleration=0.07g
Vertical acceleration=0g

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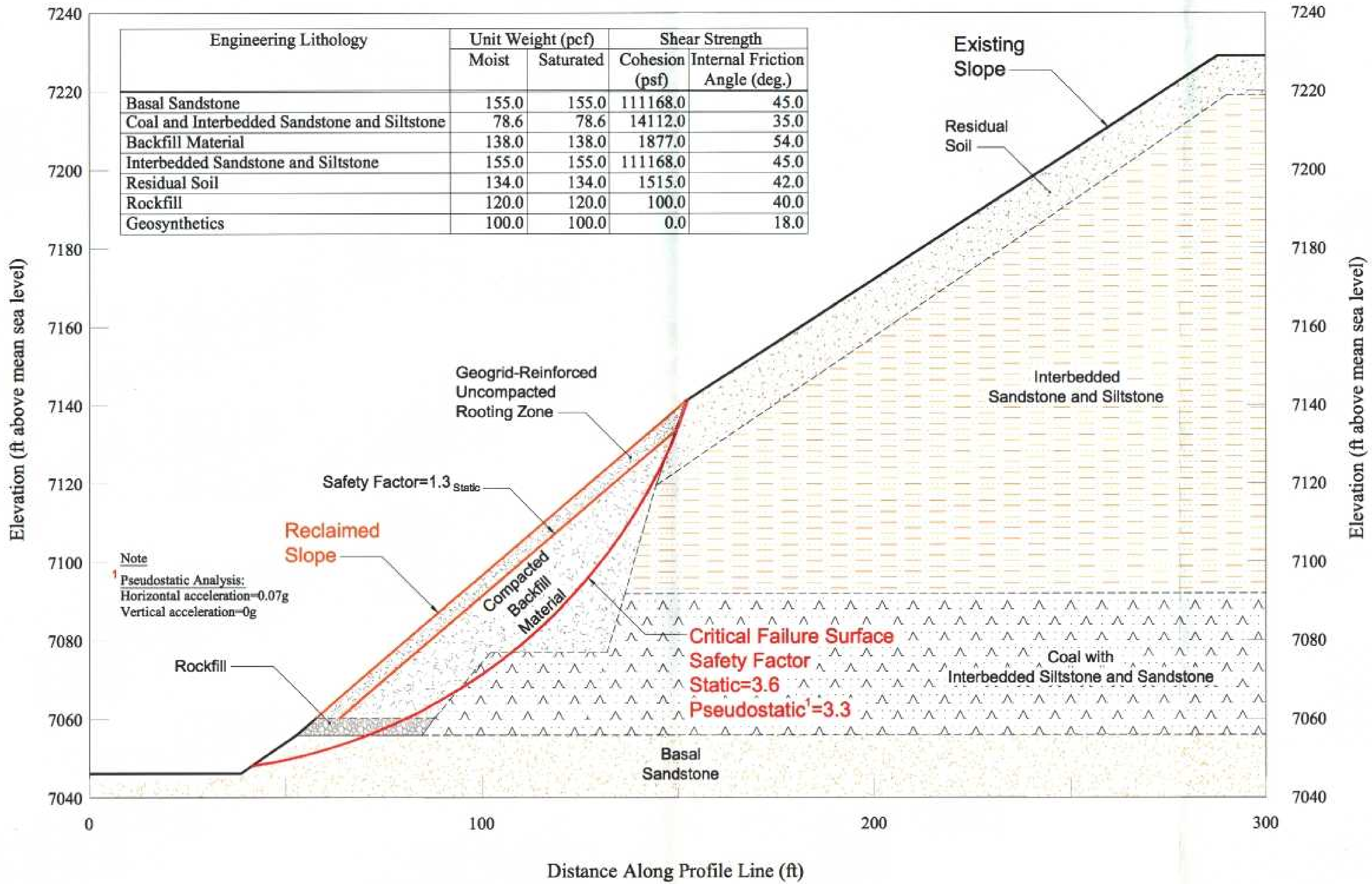
460-3 Andalex [460-3 West Ridge Geotechnical Model 3-2003.dwg Layout Fig 7-HW Stability]:rjl (3-11-2003)

Figure 7. Stability Analyses of Existing Portal Cut Slope

Engineering Lithology	Unit Weight (pcf)		Shear Strength	
	Moist	Saturated	Cohesion (psf)	Internal Friction Angle (deg.)
Basal Sandstone	155.0	155.0	111168.0	45.0
Coal and Interbedded Sandstone and Siltstone	78.6	78.6	14112.0	35.0
Backfill Material	138.0	138.0	1877.0	54.0
Interbedded Sandstone and Siltstone	155.0	155.0	111168.0	45.0
Residual Soil	134.0	134.0	1515.0	42.0
Rockfill	120.0	120.0	100.0	40.0
Geosynthetics	100.0	100.0	0.0	18.0



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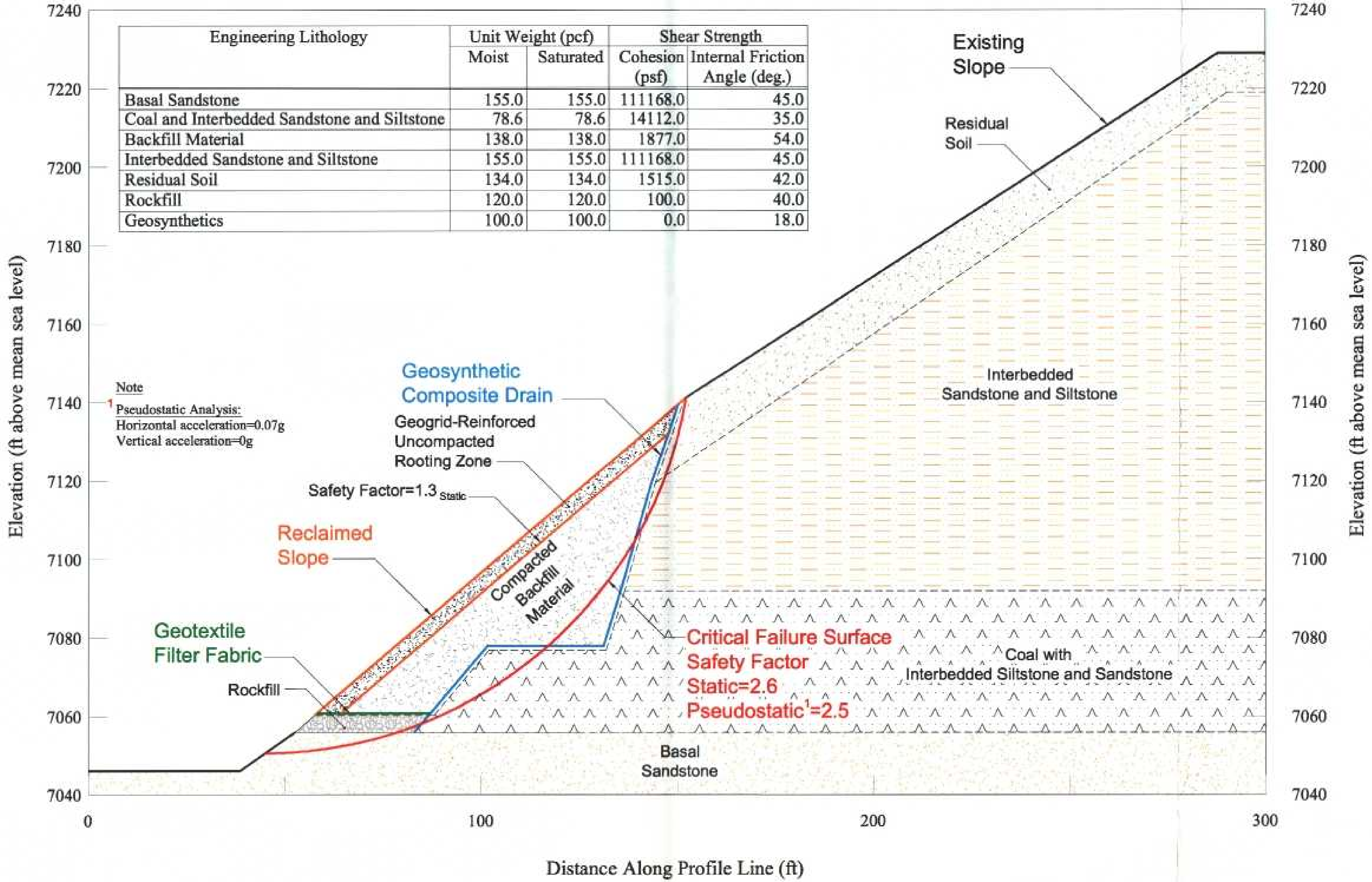
460-3 Andalex [460-3 West Ridge Geotechnical Model 3-2003.dwg Layout Fig 8-Composite Drain]:rjl (3-11-2003)

Figure 8. Stability Analyses of Reclaimed Slope Without the Geosynthetic Composite Drain



Engineering Lithology	Unit Weight (pcf)		Shear Strength	
	Moist	Saturated	Cohesion (psf)	Internal Friction Angle (deg.)
Basal Sandstone	155.0	155.0	111168.0	45.0
Coal and Interbedded Sandstone and Siltstone	78.6	78.6	14112.0	35.0
Backfill Material	138.0	138.0	1877.0	54.0
Interbedded Sandstone and Siltstone	155.0	155.0	111168.0	45.0
Residual Soil	134.0	134.0	1515.0	42.0
Rockfill	120.0	120.0	100.0	40.0
Geosynthetics	100.0	100.0	0.0	18.0

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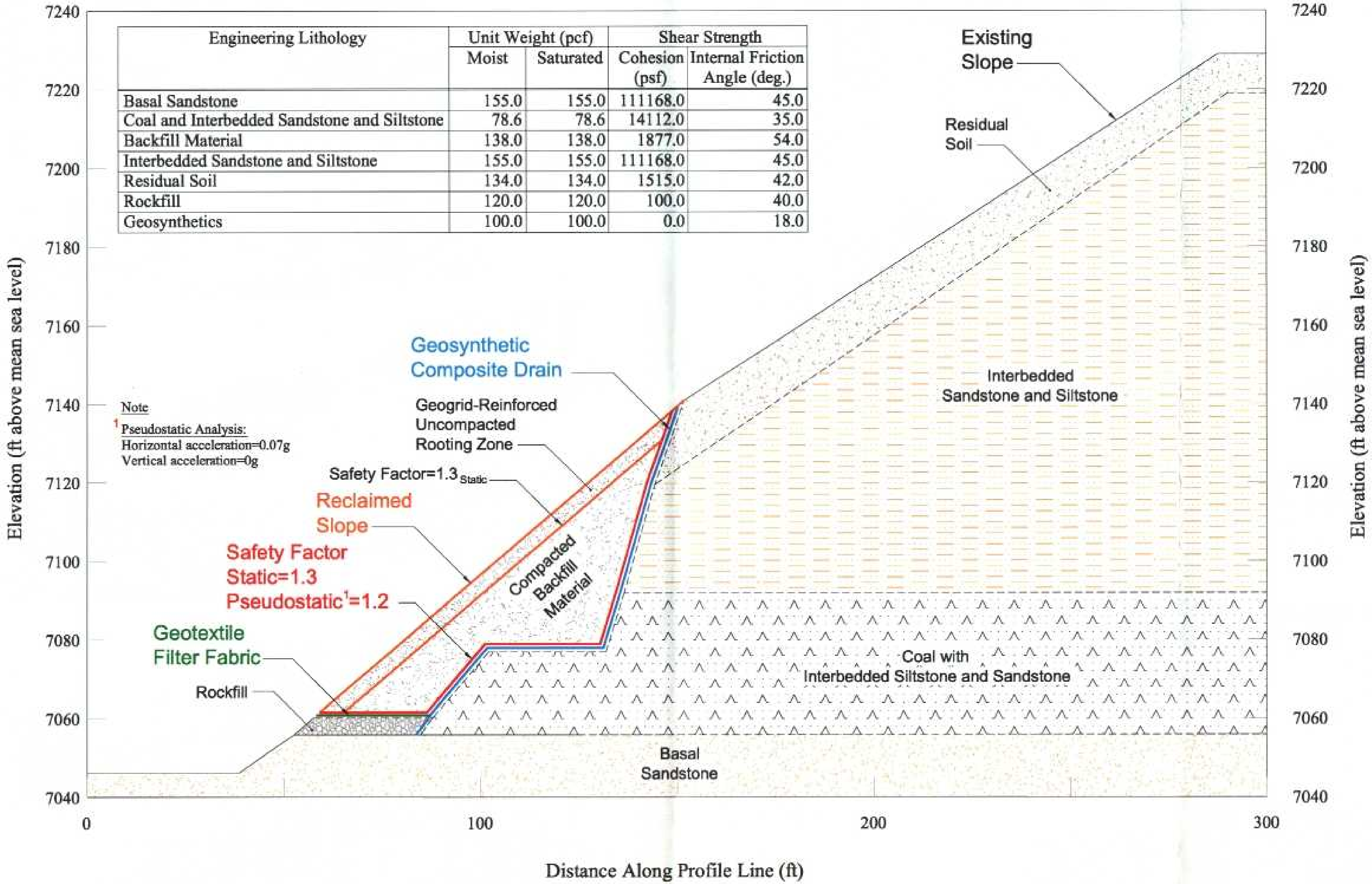
460-3 Andalex [460-3 West Ridge Geotechnical Model 3-2003.dwg Layout Fig 9-Composite Drain]:rjl (3-11-2003)

Figure 9. Stability Analyses of Reclaimed Slope With Geosynthetic Composite Drain—Rotational Failure Mode



Engineering Lithology	Unit Weight (pcf)		Shear Strength	
	Moist	Saturated	Cohesion (psf)	Internal Friction Angle (deg.)
Basal Sandstone	155.0	155.0	111168.0	45.0
Coal and Interbedded Sandstone and Siltstone	78.6	78.6	14112.0	35.0
Backfill Material	138.0	138.0	1877.0	54.0
Interbedded Sandstone and Siltstone	155.0	155.0	111168.0	45.0
Residual Soil	134.0	134.0	1515.0	42.0
Rockfill	120.0	120.0	100.0	40.0
Geosynthetics	100.0	100.0	0.0	18.0

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Figure 10. Stability Analyses of Reclaimed Slope With Geosynthetic Compostite Drain—Plane Shear Failure Mode

APPENDIX A

LABORATORY TESTING DATA

PHYSICAL PROPERTIES TESTS

RESIDUAL SOIL

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT	Agapito Associates	JOB NO.	2452-08
BORING NO.	Composite	SAMPLED	
DEPTH		DATE TESTED	1/28/03 DPM
SAMPLE NO.	RS2-1,2	WASH SIEVE	Yes
SOIL DESCR.	Proj # 460-03	DRY SIEVE	No
LOCATION	Westridge Mine		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	41.95
Wt. Dry Soil & Pan (g)	41.45
Wt. Lost Moisture (g)	0.49
Wt. of Pan Only (g)	3.67
Wt. of Dry Soil (g)	37.78
Moisture Content %	1.3
Wt. Hydrom. Sample Wet (g)	56.59
Wt. Hydrom. Sample Dry (g)	55.86

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	3768.53
Weight of + #10 Before Washing (g)	1504.52
Weight of + #10 After Washing (g)	2429.20
Weight of - #10 Wet (g)	2264.01
Weight of - #10 Dry (g)	1322.01
Wt. Total Sample Dry (g)	3751.21
Calc. Wt. "W" (g)	158.49
Calc. Mass + #10	102.64

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	1465.62	1465.62	1465.62	39.1	60.9
3/4"	0.00	353.63	353.63	1819.25	48.5	51.5
3/8"	0.00	253.32	253.32	2072.57	55.3	44.7
#4	0.00	189.49	189.49	2262.06	60.3	39.7
#10	0.00	167.14	167.14	2429.20	64.8	35.2
#20	2.36	2.99	0.63	0.63	65.2	34.8
#40	2.36	2.94	0.58	1.21	65.5	34.5
#60	2.35	4.38	2.03	3.24	66.8	33.2
#100	2.34	8.27	5.93	9.17	70.5	29.5
#200	2.28	14.00	11.72	20.89	77.9	22.1

Data entered by: RS Date: 01/31/2003
Data checked by: KR Date: 2/5/03
FileName: AOHURS2C

ADVANCED TERRA TESTING, INC.

HYDROMETER ANALYSIS - SEDIMENTATION DATA
ASTM D 422

CLIENT	Agapito Associates	JOB NO.	2452-08
BORING NO.	Composite	SAMPLED	
DEPTH		DATE TESTED	1/28/03 DPM
SAMPLE NO.	RS2-1,2	WASH SIEVE	Yes
SOIL DESCR.	Proj # 460-03	DRY SIEVE	No
LOCATION	Westridge Mine		

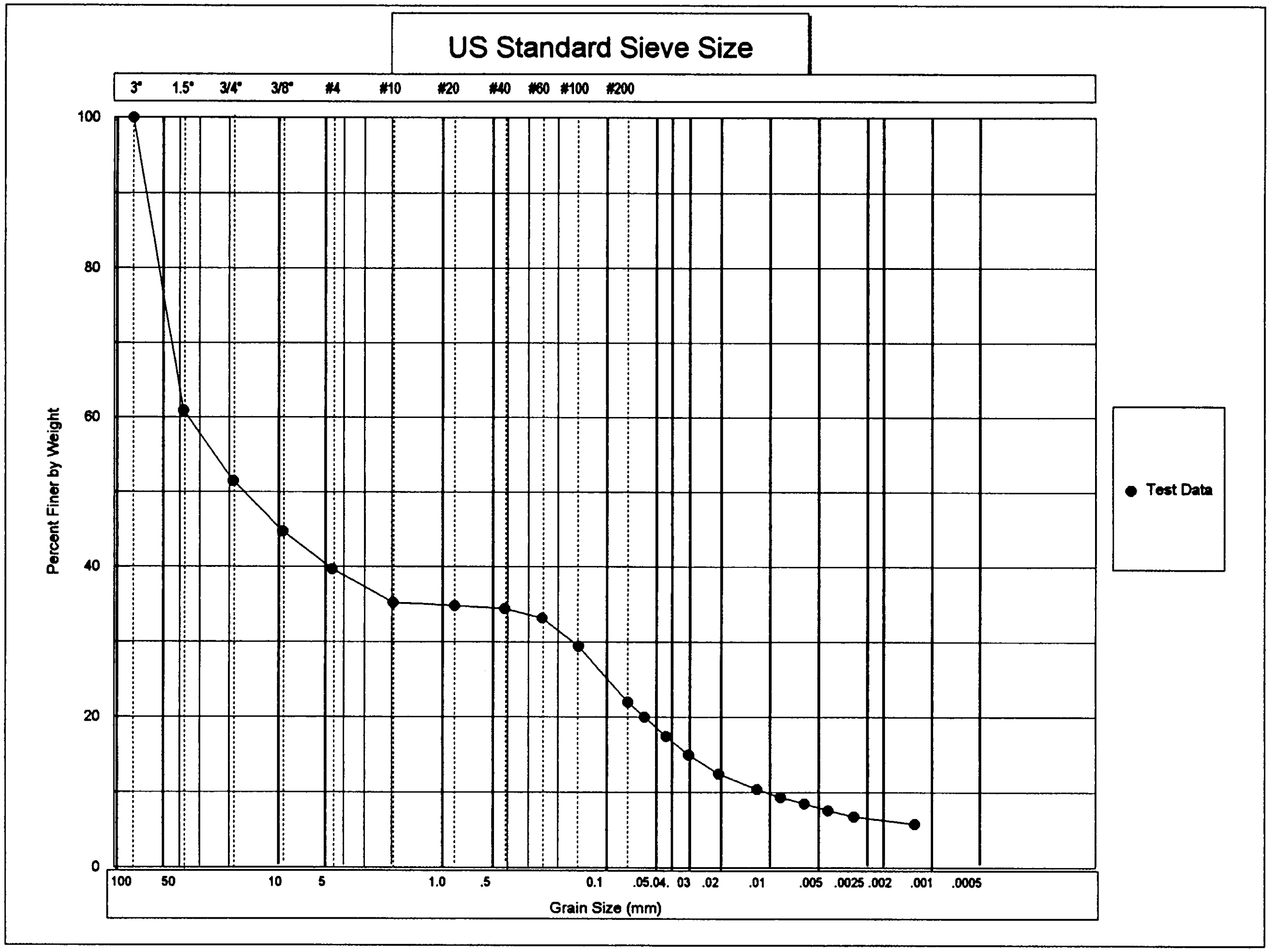
Hydrometer #	ASTM 152 H	Temp., Deg. C	23.3
Sp. Gr. of Soil	2.65	Temp. Coef. K	0.01312
Value of "alpha"	1.00	Wt. Dry Sample "W"	158.492
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	4.8		
Meniscus Corr'n	-1.5		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	–	–	–	–	–	–
0.5	38.00	31.75	20.0	20.0	10.06	0.0589
1.0	34.00	27.75	17.5	17.5	10.71	0.0430
2.0	30.00	23.75	15.0	15.0	11.37	0.0313
5.0	26.00	19.75	12.5	12.5	12.03	0.0204
15.0	22.75	16.50	10.4	10.4	12.56	0.0120
30.0	21.00	14.75	9.3	9.3	12.85	0.0086
60.0	19.75	13.50	8.5	8.5	13.05	0.0061
120.0	18.25	12.00	7.6	7.6	13.30	0.0044
250.0	17.00	10.75	6.8	6.8	13.50	0.0030
1440.0	15.50	9.25	5.8	5.8	13.75	0.0013

Grain Diameter = K*(SQRT(L/T))

Data entered by: RS Date: 01/31/2003
Data checked by: KR Date: 2/5/03
FileName: AOHURS2C

ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY	
	COARSE	FINE	CRS	MEDIUM	FINE		USCS

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			WENTWORTH

Client: Agapito Associates   Boring No.: Composite   Sample No.: RS2-1,2

Job Number: 2452-08   Depth:

Classification: GC, Clayey gravel with sand

Advanced Terra Testing, Inc.

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT	Agapito Associates	JOB NO.	2452-08
BORING NO.	Composite	SAMPLED	
DEPTH		DATE TESTED	01-23-03 DPM
SAMPLE NO.	RS1-1,2,3	WASH SIEVE	Yes
SOIL DESCR.	Project #460-03	DRY SIEVE	No
LOCATION	Westridge Mine		

MOISTURE DATA

HYGROSCOPIC	Yes	
NATURAL	No	
Wt. Wet Soil & Pan (g)		51.27
Wt. Dry Soil & Pan (g)		49.60
Wt. Lost Moisture (g)		1.67
Wt. of Pan Only (g)		3.66
Wt. of Dry Soil (g)		45.94
Moisture Content %		3.6
Wt. Hydrom. Sample Wet (g)		201.36
Wt. Hydrom. Sample Dry (g)		194.30

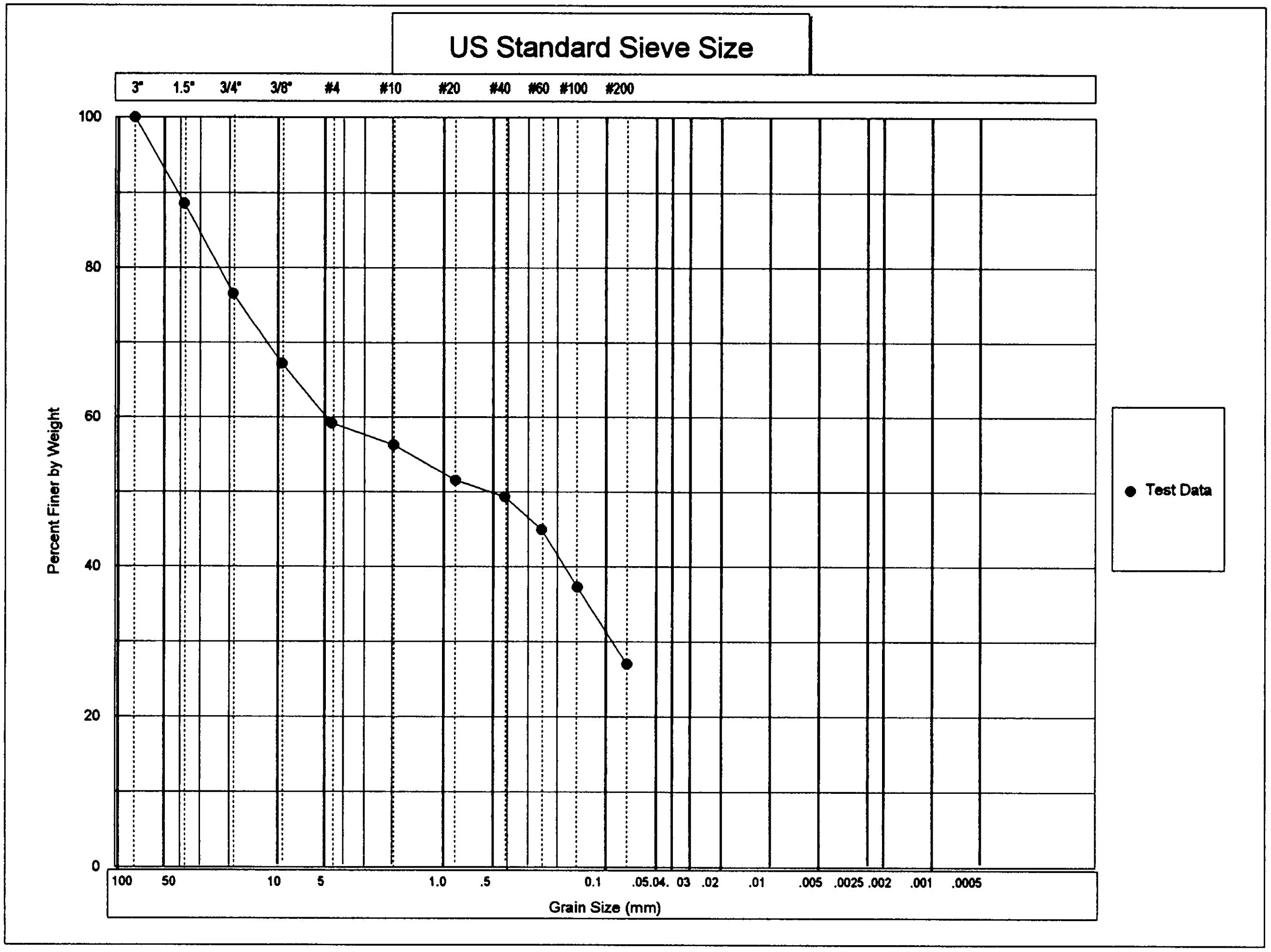
WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	4677.27
Weight of + #10 Before Washing (g)	2101.29
Weight of + #10 After Washing (g)	2001.57
Weight of - #10 Wet (g)	2575.98
Weight of - #10 Dry (g)	2581.89
Wt. Total Sample Dry (g)	4583.46
Calc. Wt. "W" (g)	344.93
Calc. Mass + #10	150.63

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	522.46	522.46	522.46	11.4	88.6
3/4"	0.00	550.23	550.23	1072.69	23.4	76.6
3/8"	0.00	429.92	429.92	1502.61	32.8	67.2
#4	0.00	369.00	369.00	1871.61	40.8	59.2
#10	0.00	129.96	129.96	2001.57	43.7	56.3
#20	3.75	20.12	16.37	16.37	48.4	51.6
#40	3.65	11.33	7.68	24.05	50.6	49.4
#60	3.73	18.78	15.05	39.10	55.0	45.0
#100	3.57	29.96	26.39	65.49	62.7	37.3
#200	3.68	39.30	35.62	101.11	73.0	27.0

Data entered by: SR Date: 02/03/2003
Data checked by: KR Date: 2/5/03
FileName: AOHURS11

ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: Agapito Associates   Boring No.: Composite   Sample No.: RS1-1,2,3

Job Number: 2452-08   Depth:

Classification: **<u>GC-GM, Silty, clayey gravel with sand</u>**

Advanced Terra Testing, Inc.

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Agapito Associates	JOB NO.	2452-08
BORING NO.	Composite	DATE SAMPLED	
DEPTH		DATE TESTED	01-28-03 RS
SAMPLE NO.	RS1-1,2,3		
SOIL DESCR.	Project #460-03		
LOCATION	Westridge Mine		

Plastic Limit
Determination

	1	2	3
Wt Dish & Wet Soil	5.56	5.74	5.99
Wt Dish & Dry Soil	4.71	4.86	5.08
Wt of Moisture	0.85	0.88	0.91
Wt of Dish	0.77	0.77	0.74
Wt of Dry Soil	3.94	4.09	4.34
Moisture Content	21.57	21.52	20.97

Liquid Limit Determination   Device Number   0966

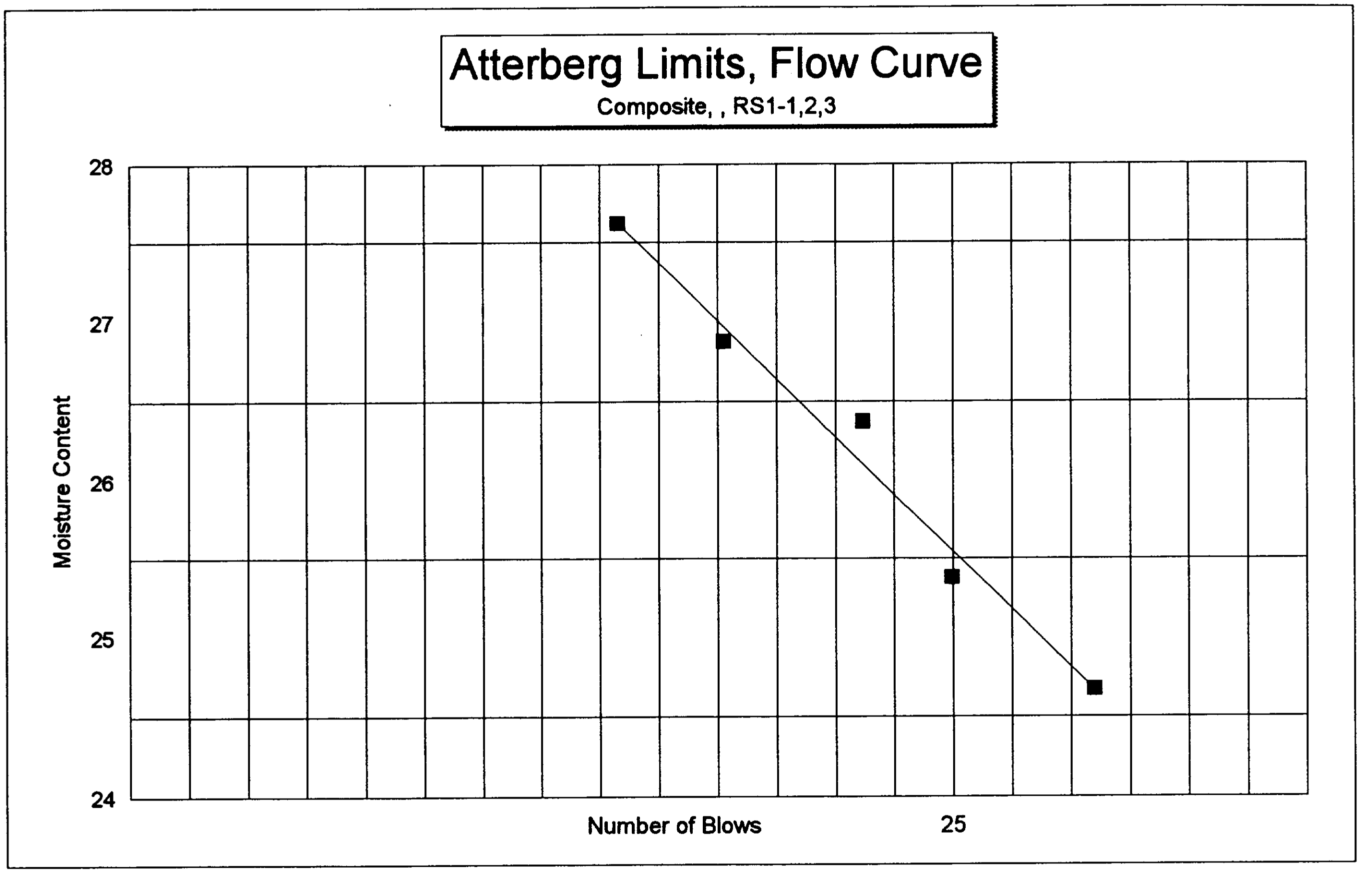
	1	2	3	4	5
Number of Blows	13	16	21	25	33
Wt Dish & Wet Soil	12.31	11.77	12.24	12.28	11.31
Wt Dish & Dry Soil	9.81	9.44	9.84	9.95	9.22
Wt of Moisture	2.50	2.33	2.40	2.33	2.09
Wt of Dish	0.76	0.77	0.74	0.77	0.75
Wt of Dry Soil	9.05	8.67	9.10	9.18	8.47
Moisture Content	27.62	26.87	26.37	25.38	24.68

Liquid Limit	25.6
Plastic Limit	21.4
Plasticity Index	4.2

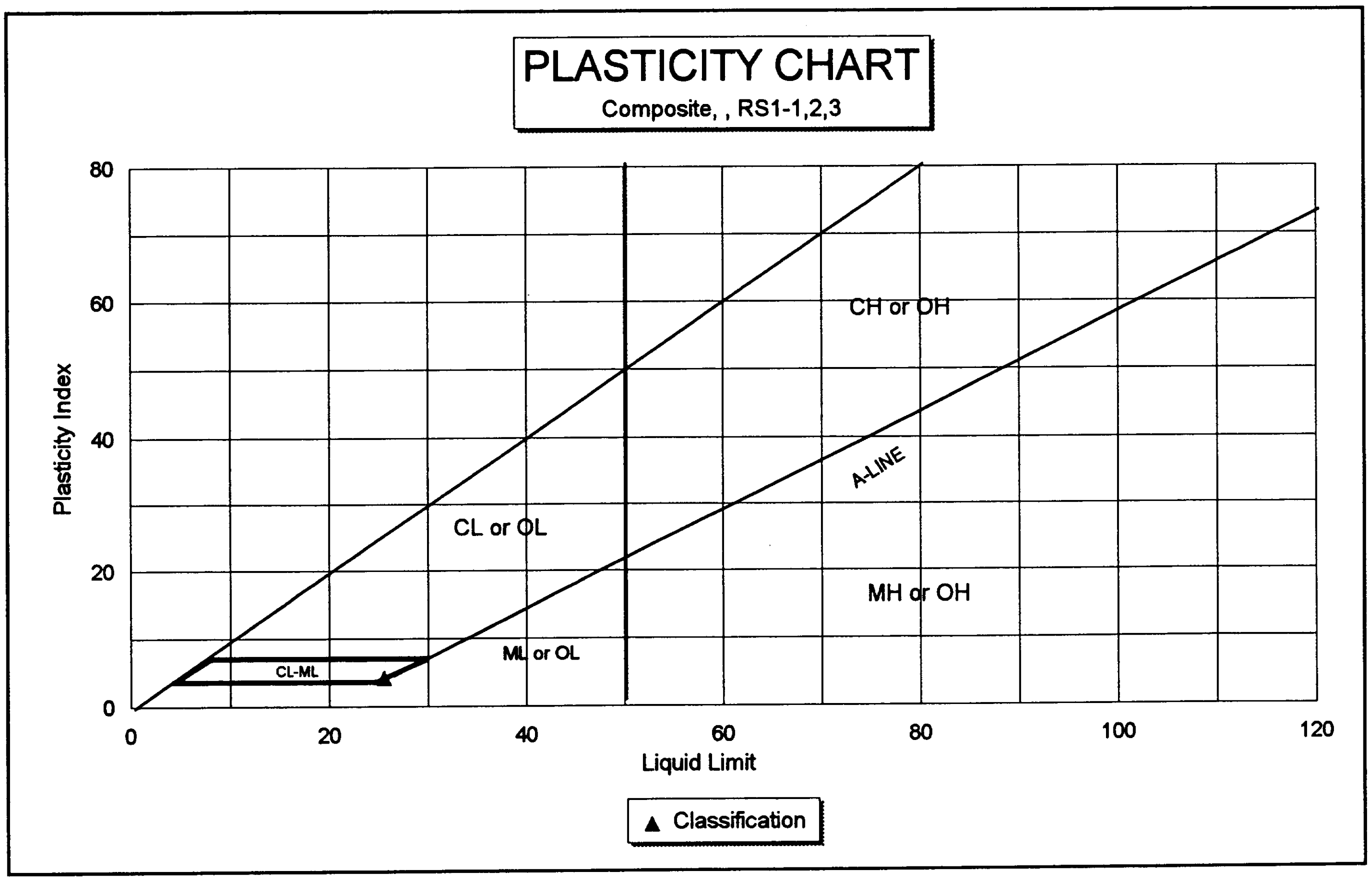
Atterberg Classification   CL-ML

Data entry by: SR   Date: 01/29/2003
Checked by: ld   Date: 1/30/03
FileName: AOG0RS11

ADVANCED TERRA TESTING, INC.



Atterberg Limits, Flow Curve
Composite, , RS1-1,2,3
28
27
26
25
24
Moisture Content
Number of Blows
25



PLASTICITY CHART
Composite, , RS1-1,2,3
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
▲ Classification

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Agapito Associates	JOB NO.	2452-08
BORING NO.	Composite	DATE SAMPLED	
DEPTH		DATE TESTED	01-28-03 RS
SAMPLE NO.	RS2-1,2		
SOIL DESCR.	Project #460-03		
LOCATION	Westridge Mine		

Plastic Limit Determination

	1	2	3
Wt Dish & Wet Soil	5.87	7.41	7.22
Wt Dish & Dry Soil	5.06	6.36	6.20
Wt of Moisture	0.81	1.05	1.02
Wt of Dish	0.76	0.74	0.74
Wt of Dry Soil	4.30	5.62	5.46
Moisture Content	18.84	18.68	18.68

Liquid Limit Determination   Device Number   0966

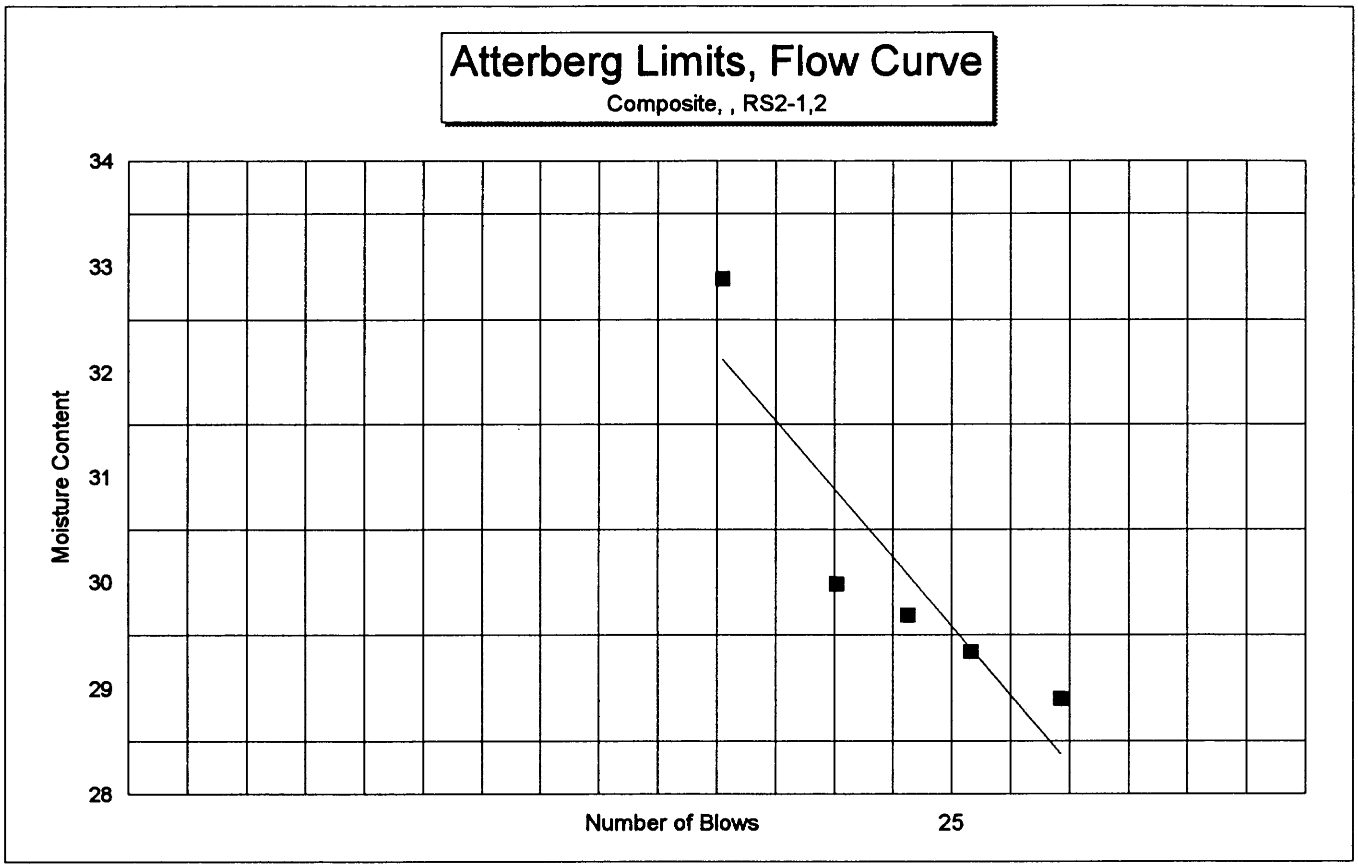
	1	2	3	4	5
Number of Blows	16	20	23	31	26
Wt Dish & Wet Soil	11.64	10.97	11.53	11.33	12.87
Wt Dish & Dry Soil	8.95	8.61	9.06	8.96	10.12
Wt of Moisture	2.69	2.36	2.47	2.37	2.75
Wt of Dish	0.77	0.74	0.74	0.76	0.75
Wt of Dry Soil	8.18	7.87	8.32	8.20	9.37
Moisture Content	32.89	29.99	29.69	28.90	29.35

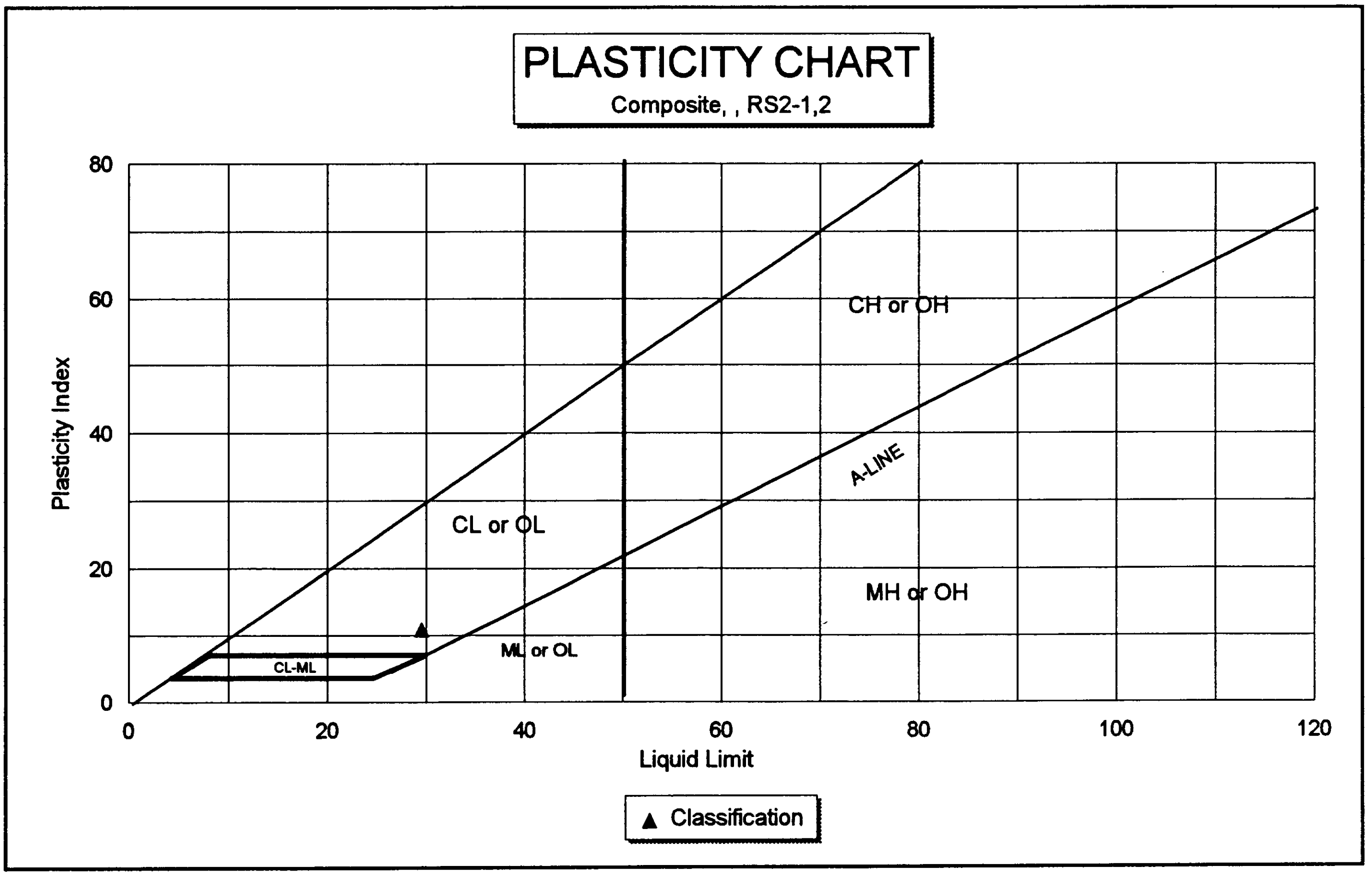
Liquid Limit	29.6
Plastic Limit	18.7
Plasticity Index	10.9

Atterberg Classification   CL

Data entry by: SR   Date: 01/29/2003
Checked by: RR   Date: 1/30/03
FileName: AOG0RS21

ADVANCED TERRA TESTING, INC.


Atterberg Limits, Flow Curve
Composite, , RS2-1,2
34
33
32
31
30
29
28
Moisture Content
Number of Blows
25


PLASTICITY CHART
Composite, , RS2-1,2
80
60
40
20
0
Plasticity Index
0
20
40
60
80
100
120
Liquid Limit
CH or OH
A-LINE
CL or OL
MH or OH
CL-ML
ML or OL
▲ Classification

PHYSICAL PROPERTIES TESTS

TOPSOIL

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Agapito Associates	JOB NO.	2452-08
BORING NO.	Composite	DATE SAMPLED	
DEPTH		DATE TESTED	01-24-03 RS
SAMPLE NO.	Top Soil, 1,2,3,4,5		
SOIL DESCR.	Project #460-03		
LOCATION			

Plastic Limit
Determination

	1	2	3
Wt Dish & Wet Soil	5.00	4.92	3.86
Wt Dish & Dry Soil	4.35	4.28	3.40
Wt of Moisture	0.65	0.64	0.46
Wt of Dish	0.75	0.76	0.77
Wt of Dry Soil	3.60	3.52	2.63
Moisture Content	18.06	18.18	17.49

Liquid Limit Determination   Device Number 0966

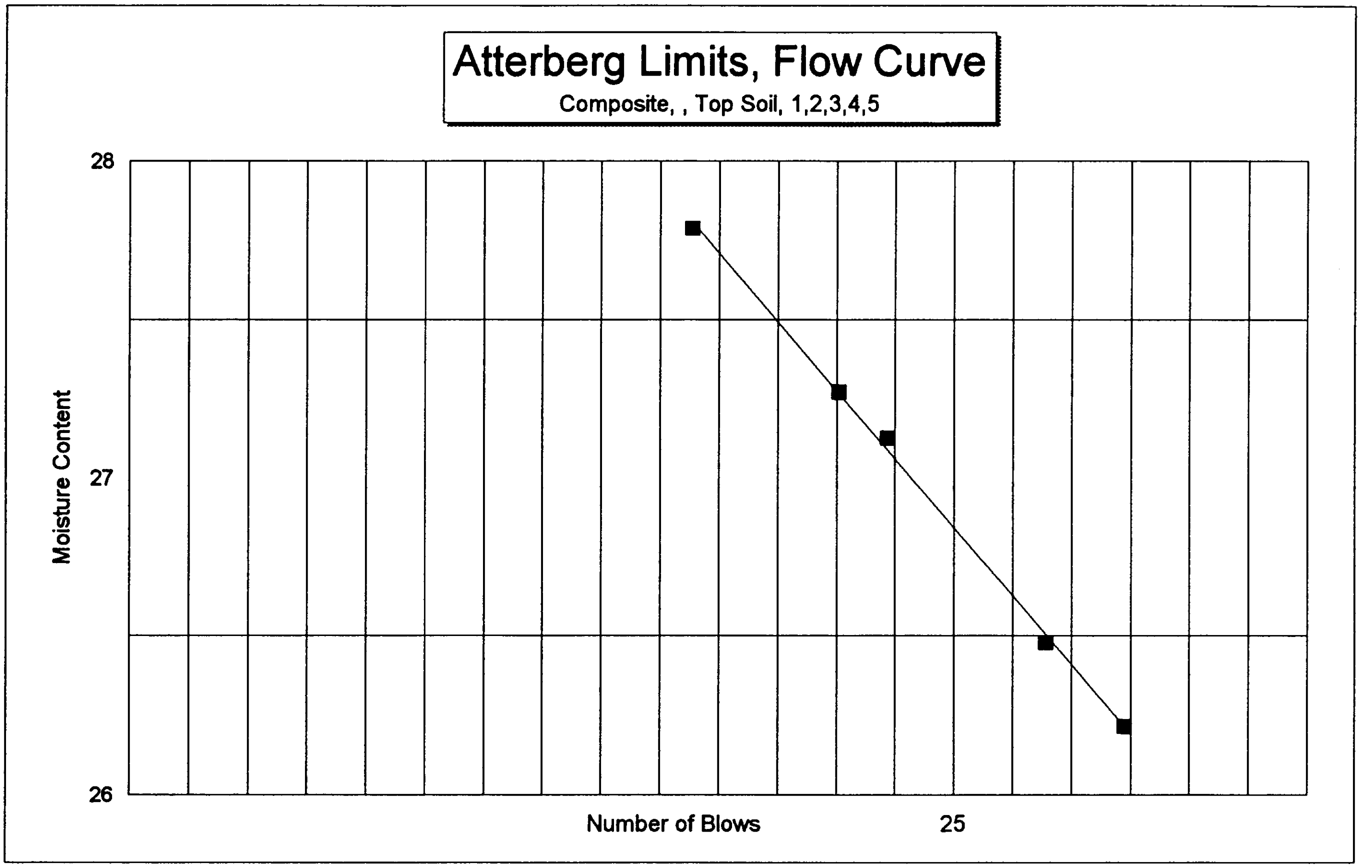
	1	2	3	4	5
Number of Blows	15	20	22	30	35
Wt Dish & Wet Soil	13.11	12.64	12.71	13.38	13.23
Wt Dish & Dry Soil	10.42	10.09	10.16	10.74	10.64
Wt of Moisture	2.69	2.55	2.55	2.64	2.59
Wt of Dish	0.74	0.74	0.76	0.77	0.76
Wt of Dry Soil	9.68	9.35	9.40	9.97	9.88
Moisture Content	27.79	27.27	27.13	26.48	26.21

Liquid Limit	26.8
Plastic Limit	17.9
Plasticity Index	8.9

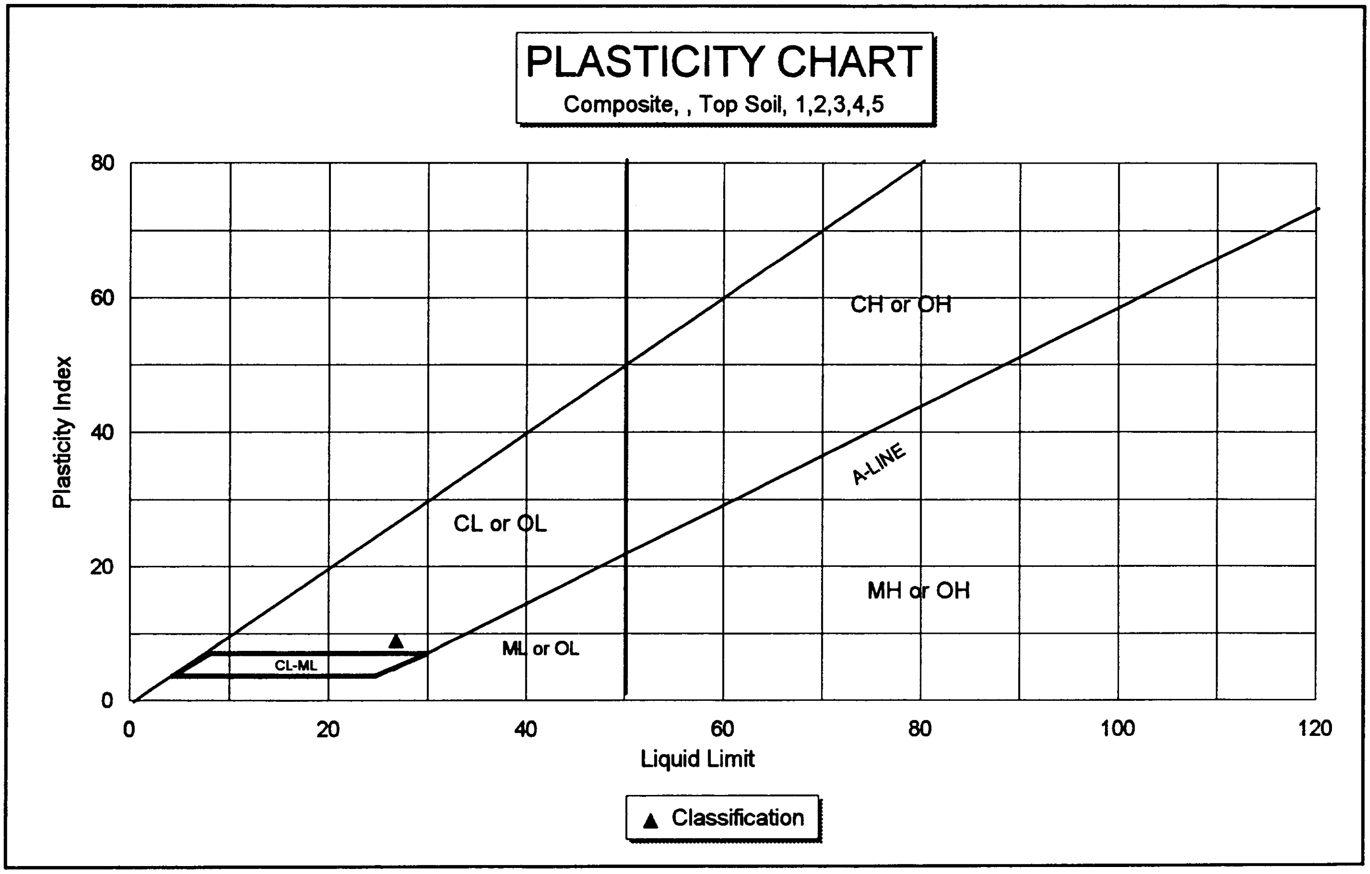
Atterberg Classification CL

Data entry by: SR   Date: 01/27/2003
Checked by: [signature]   Date: 1/23/03
FileName: AOG0TPSL

ADVANCED TERRA TESTING, INC.



Atterberg Limits, Flow Curve
Composite, , Top Soil, 1,2,3,4,5
28
27
26
Moisture Content
Number of Blows
25



PLASTICITY CHART
Composite, , Top Soil, 1,2,3,4,5
80
60
40
20
0
Plasticity Index
CH or OH
A-LINE
CL or OL
MH or OH
ML or OL
CL-ML
0
20
40
60
80
100
120
Liquid Limit
Classification

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT Agapito Associates

JOB NO. 2452-08

BORING NO.	Composite
DEPTH	
SAMPLE NO.	Top Soil, 1,2,3,4,5
SOIL DESCR.	Project #460-03
LOCATION	Westridge Mine

SAMPLED	
DATE TESTED	01-22-03 RS
WASH SIEVE	Yes
DRY SIEVE	No

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	61.88
Wt. Dry Soil & Pan (g)	61.03
Wt. Lost Moisture (g)	0.85
Wt. of Pan Only (g)	3.62
Wt. of Dry Soil (g)	57.41
Moisture Content %	1.5
Wt. Hydrom. Sample Wet (g)	251.72
Wt. Hydrom. Sample Dry (g)	248.06

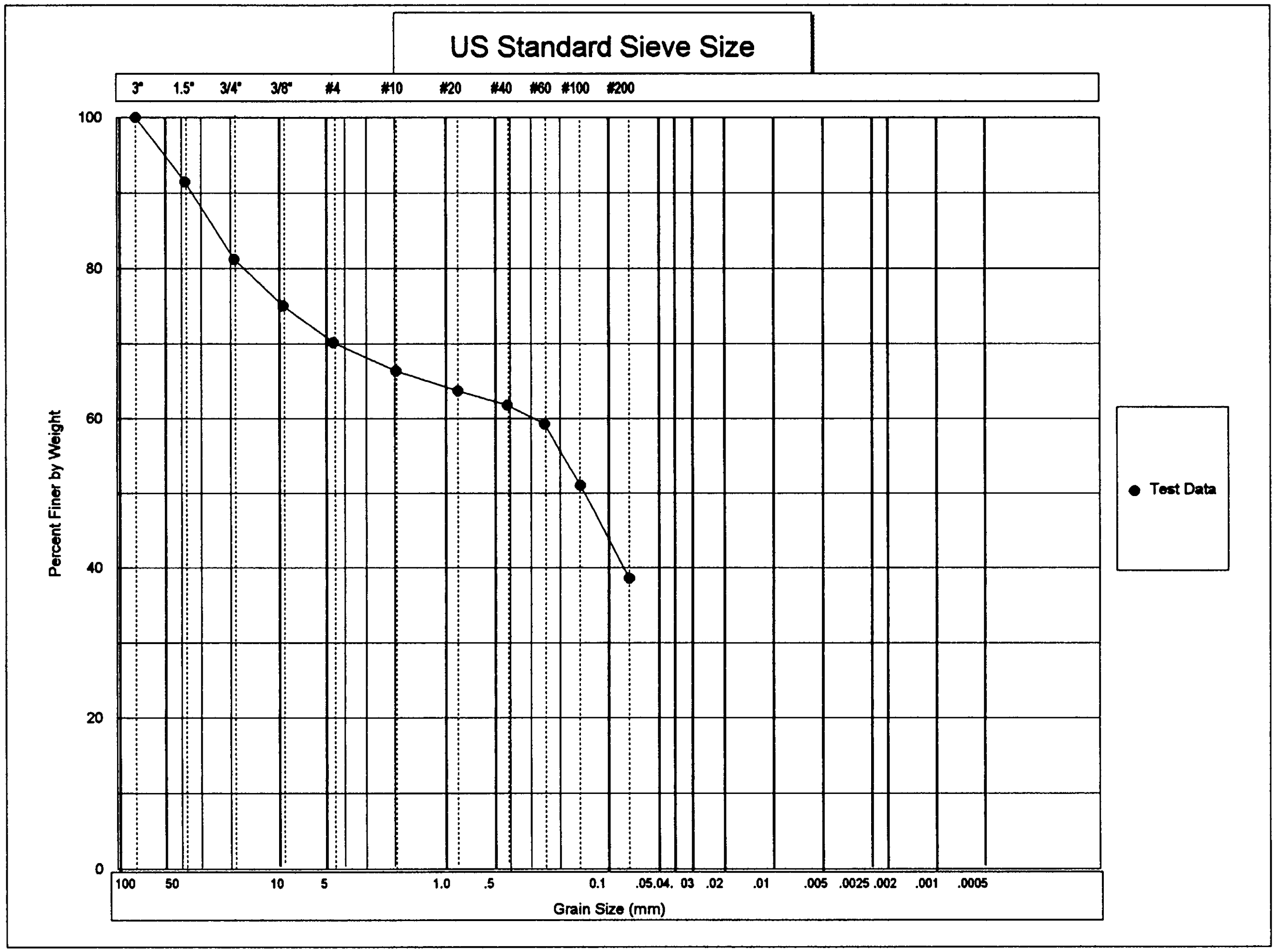
WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	4437.79
Weight of + #10 Before Washing (g)	1599.22
Weight of + #10 After Washing (g)	1479.75
Weight of - #10 Wet (g)	2838.57
Weight of - #10 Dry (g)	2915.03
Wt. Total Sample Dry (g)	4394.78
Calc. Wt. "W" (g)	373.98
Calc. Mass + #10	125.92

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	375.96	375.96	375.96	8.6	91.4
3/4"	0.00	447.93	447.93	823.89	18.7	81.3
3/8"	0.00	271.04	271.04	1094.93	24.9	75.1
#4	0.00	214.79	214.79	1309.72	29.8	70.2
#10	0.00	170.03	170.03	1479.75	33.7	66.3
#20	3.57	13.37	9.80	9.80	36.3	63.7
#40	3.64	10.68	7.04	16.84	38.2	61.8
#60	3.56	12.88	9.32	26.16	40.7	59.3
#100	3.66	34.62	30.96	57.12	48.9	51.1
#200	3.64	50.07	46.43	103.55	61.4	38.6

Data entered by: SR Date: 01/27/2003
Data checked by: LS Date: 1/28/03
FileName: AOMUTPSL

ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY	USCS
	COARSE	FINE	CRS	MEDIUM	FINE		

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY	WENTWORTH
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE			

Client: Agapito Associates Boring No.: Composite Sample No.: Top Soil, 1,2,3,4,5

Job Number: 2452-08 Depth:

Classification: **SC, Clayey sand with gravel**

Advanced Terra Testing, Inc.

PHYSICAL PROPERTIES TESTS

BACKFILL

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT Agapito Associates

JOB NO. 2452-08

BORING NO.	Composite	SAMPLED	
DEPTH		DATE TESTED	
SAMPLE NO.	Backfill 1,2,3,4,5	WASH SIEVE	Yes
SOIL DESCR.	Project #460-03	DRY SIEVE	No
LOCATION	Westridge Mine		

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No
Wt. Wet Soil & Pan (g)	53.42
Wt. Dry Soil & Pan (g)	52.99
Wt. Lost Moisture (g)	0.43
Wt. of Pan Only (g)	3.65
Wt. of Dry Soil (g)	49.34
Moisture Content %	0.9
Wt. Hydrom. Sample Wet (g)	213.72
Wt. Hydrom. Sample Dry (g)	211.89

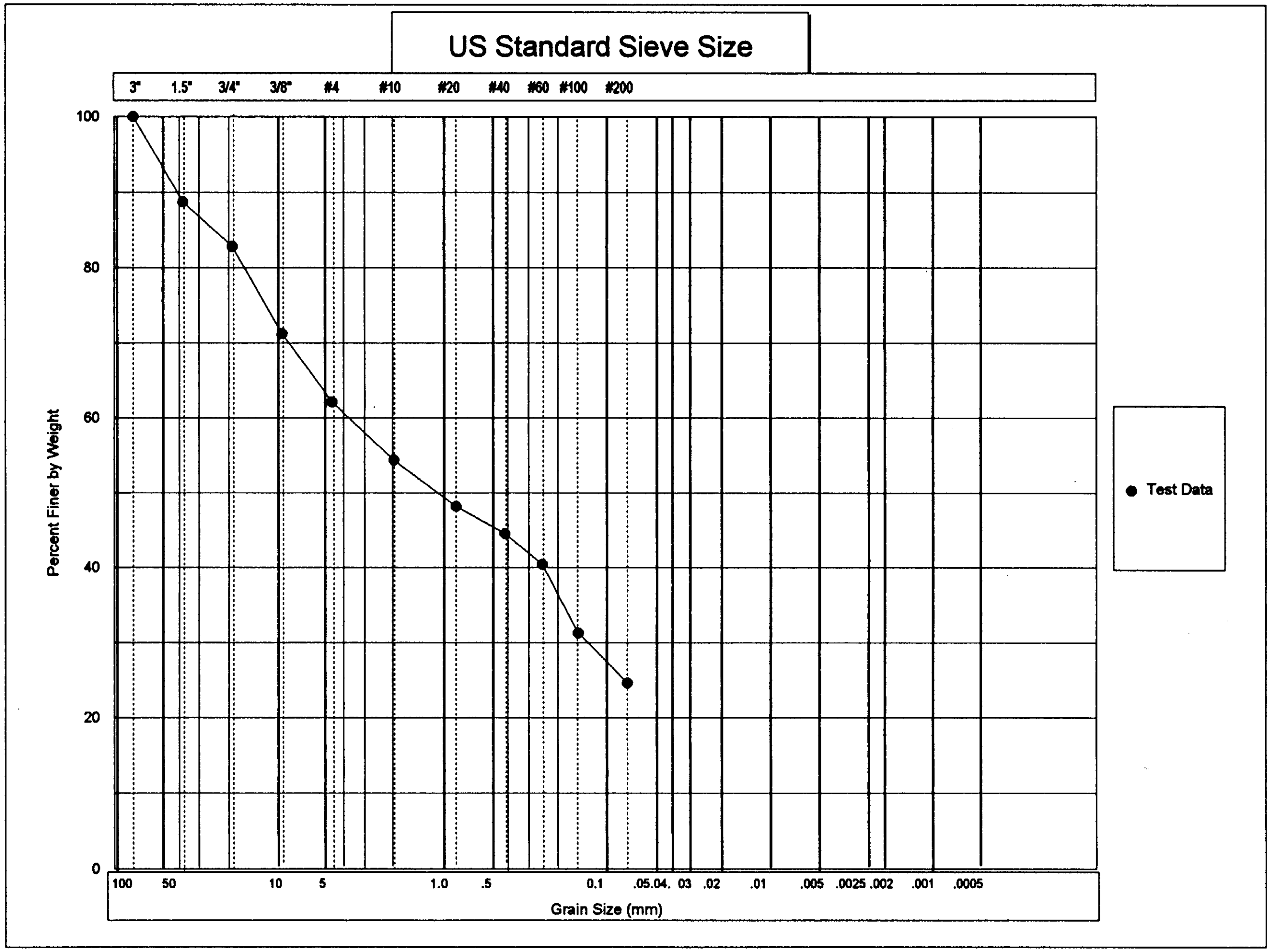
WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	3819.92
Weight of + #10 Before Washing (g)	1930.80
Weight of + #10 After Washing (g)	1733.91
Weight of - #10 Wet (g)	1889.12
Weight of - #10 Dry (g)	2068.15
Wt. Total Sample Dry (g)	3802.06
Calc. Wt. "W" (g)	389.54
Calc. Mass + #10	177.65

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	426.30	426.30	426.30	11.2	88.8
3/4"	0.00	225.67	225.67	651.97	17.1	82.9
3/8"	0.00	441.55	441.55	1093.52	28.8	71.2
#4	0.00	345.67	345.67	1439.19	37.9	62.1
#10	0.00	294.72	294.72	1733.91	45.6	54.4
#20	3.73	28.01	24.28	24.28	51.8	48.2
#40	3.59	17.67	14.08	38.36	55.5	44.5
#60	3.62	19.54	15.92	54.28	59.5	40.5
#100	3.69	39.38	35.69	89.97	68.7	31.3
#200	3.58	29.43	25.85	115.82	75.3	24.7

Data entered by: SR Date: 01/24/2003
Data checked by: Cue Date: 01/29/03
FileName: AOMU1234

ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client: Agapito Associates Boring No.: Composite Sample No.: Backfill 1,2,3,4,5

Job Number: 2452-08 Depth:

Classification: **GM, Silty gravel with sand**

Advanced Terra Testing, Inc.

ATTERBERG LIMITS TEST
ASTM D 4318

CLIENT	Agapito Associates	JOB NO.	2452-08
BORING NO.	Composite	DATE SAMPLED	
DEPTH		DATE TESTED	01-24-03 RS
SAMPLE NO.	Backfill 1,2,3,4,5		
SOIL DESCR.	Project #460-03		
LOCATION	Westridge Mine		

Plastic Limit
Determination

Wt Dish & Wet Soil	
Wt Dish & Dry Soil	
Wt of Moisture	
Wt of Dish	NON-PLASTIC
Wt of Dry Soil	
Moisture Content	

Liquid Limit Determination — Device Number 0966

Number of Blows

Wt Dish & Wet Soil	
Wt Dish & Dry Soil	
Wt of Moisture	
Wt of Dish	NON-PLASTIC
Wt of Dry Soil	
Moisture Content	

Liquid Limit	NP
Plastic Limit	NP
Plasticity Index	NP

Atterberg Classification NP

Data entry by:	SR	Date:	01/24/2003
Checked by: cac		Date: 1/29/03	
FileName:	AOG0CPBC		ADVANCED TERRA TESTING, INC.

Moisture Content Determinations
ASTM D 2216

CLIENT: Agapito Associates — JOB NO.: 2452-08
LOCATION: Westridge Mine, Project #460-03

BORING	Composite	Composite	Composite	Composite
SAMPLE DEPTH				
SAMPLE NO.	Backfill 1,2,3,4,5	Top Soil 1,2,3,4,5	RS2-1,2	RS1-1,2,3
DATE SAMPLED				
DATE TESTED	01-16-03 RS	01-16-03 RS	01-16-03 RS	01-16-03 RS
SOIL DESCRIPTION				
MOISTURE DETERMINATIONS				
Wt. of Wet Soil & Dish (gms)	1330.20	732.46	1198.30	1009.01
Wt. of Dry Soil & Dish (gms)	1240.53	646.47	1049.54	864.87
Net Loss of Moisture (gms)	89.67	85.99	148.76	144.14
Wt. of Dish (gms)	15.09	14.95	15.24	15.19
Wt. of Dry Soil (gms)	1225.44	631.52	1034.30	849.68
Moisture Content (%)	7.3	13.6	14.4	17.0

Data entered by: SR Date: 01/17/2003
Data checked by: cal Date: 1/17/03
FileName: AON01234

ADVANCED TERRA TESTING, INC.

STANDARD PROCTOR TEST

BACKFILL

COMPACTION TEST
ASTM D 698 C

CLIENT:	Agapito Associates	JOB NO.	2452-08
BORING NO.	Composite	DATE SAMPLED	
DEPTH		DATE TESTED	01/24/03 RS
SAMPLE NO.	Backfill - 1,2,3,4,5	LOCATION	Westridge Mine
SOIL DESCR.	Proj #460-03		

Moisture Determination

	1	2	3	4
Wt of Moisture added (ml)	300.00	200.00	100.00	0.00
Wt. of soil & dish (g)	1193.27	1136.41	1094.83	1013.59
Dry wt. soil & dish (g)	1063.27	1036.88	1016.97	963.62
Net loss of moisture (g)	130.00	99.53	77.86	49.97
Wt. of dish (g)	15.99	15.11	15.32	15.28
Net wt. of dry soil (g)	1047.28	1021.77	1001.65	948.34
Moisture Content (%)	12.41	9.74	7.77	5.27
Corrected Moisture Content	10.63	8.35	6.66	4.52

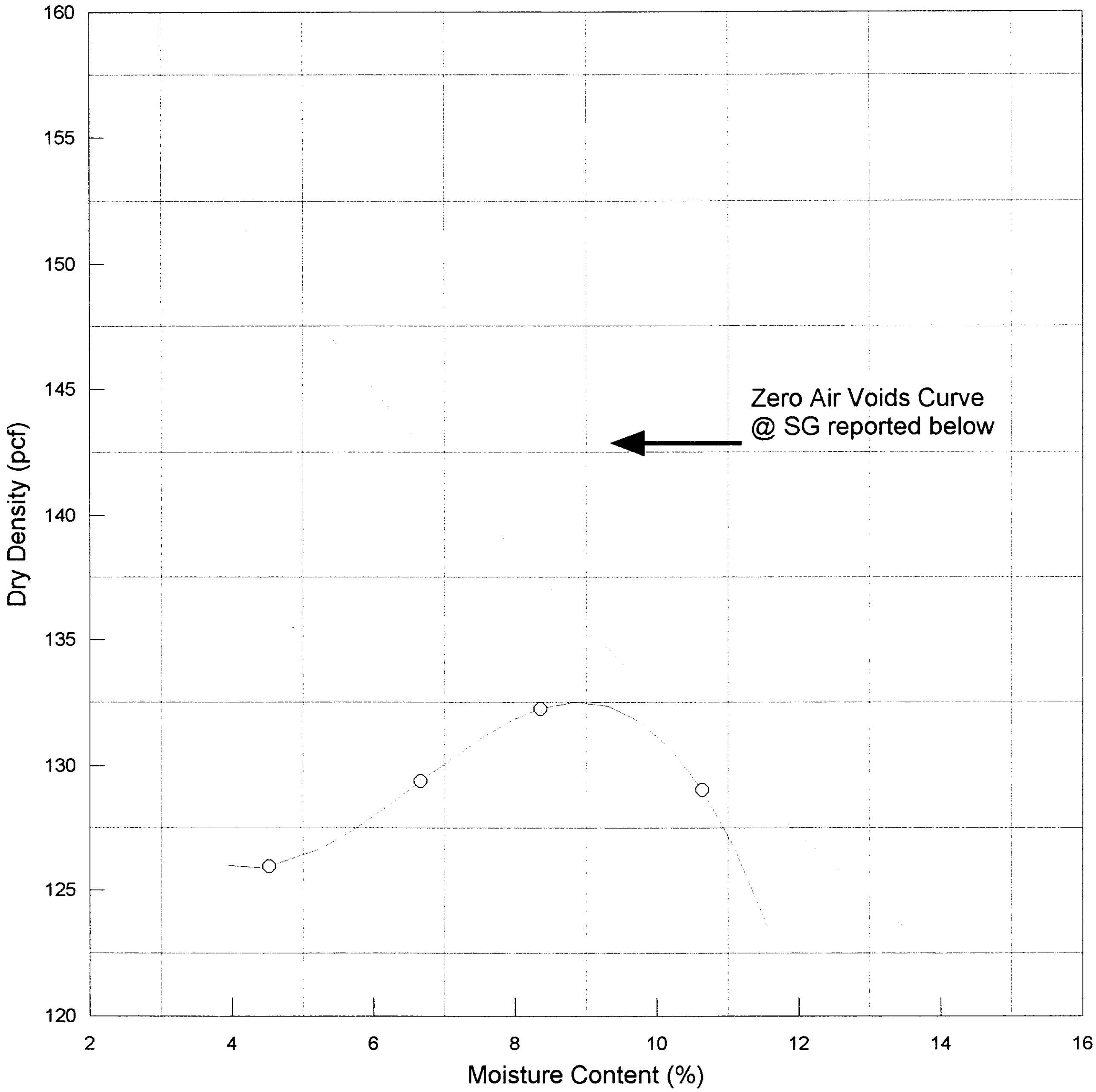
Density determination

Wt of soil & mold (lb)	24.79	24.86	24.45	23.96
Wt. of mold (lb)	14.49	14.49	14.49	14.49
Net wt. of wet soil (lb)	10.30	10.37	9.96	9.47
Net wt of dry soil (lb)	9.31	9.57	9.34	9.06
Dry Density, (pcf)	124.13	127.61	124.50	120.80
Corrected Dry Density (pcf)	129.04	132.25	129.38	125.95
Volume Factor	13.33333	13.3333333	13.33333	13.33333

Data entered by: RS Date: 01/29/2003
Data checked by: Cse Date: 01/29/03
FileName: AOPRCOMB ADVANCED TERRA TESTING, INC

Proctor Compaction Test

Composite, , Backfill - 1,2,3,4,5



Best Fit Curve ○ Actual Data

Zero Air VoidsCurve @ SG = 2.70

OPTIMUM MOISTURE CONTENT = 8.9 MAXIMUM DRY DENSITY = 132.5
ASTM D 698 C, Rock correction applied? Y

ADVANCED TERRA TESTING, INC.

STANDARD PROCTOR TEST

RESIDUAL SOIL

COMPACTION TEST
ASTM D 698 C

CLIENT:	Agapito Associates	JOB NO.	2452-08
BORING NO.	Composite	DATE SAMPLED	
DEPTH		DATE TESTED	2-16-03 RS
SAMPLE NO.	RS1&RS2	LOCATION	Westridge Mine
SOIL DESCR.			

Moisture Determination	1	2	3	4
Wt of Moisture added (ml)	600.00	500.00	400.00	300.00
Wt. of soil & dish (g)	1001.35	1132.54	1002.50	1158.00
Dry wt. soil & dish (g)	854.90	985.40	895.52	1050.16
Net loss of moisture (g)	146.45	147.14	106.98	107.84
Wt. of dish (g)	16.00	15.99	16.00	14.90
Net wt. of dry soil (g)	838.90	969.41	879.52	1035.26
Moisture Content (%)	17.46	15.18	12.16	10.42
Corrected Moisture Content	13.63	11.85	9.50	8.14

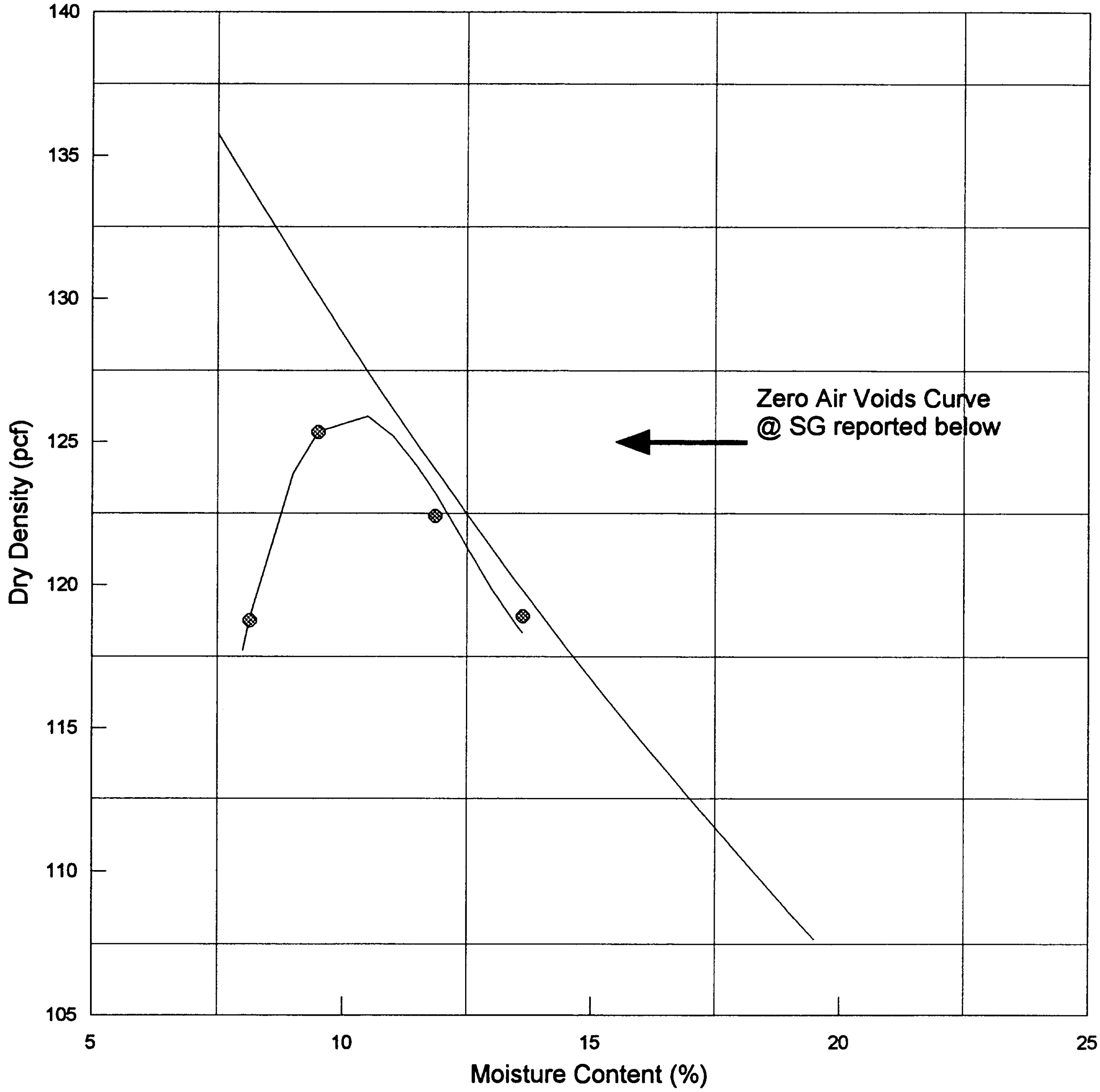
Density determination				
Wt of soil & mold (lb)	23.91	24.09	24.16	23.44
Wt. of mold (lb)	14.49	14.49	14.49	14.49
Net wt. of wet soil (lb)	9.42	9.60	9.67	8.95
Net wt of dry soil (lb)	8.29	8.58	8.83	8.28
Dry Density, (pcf)	110.54	114.44	117.75	110.35
Corrected Dry Density (pcf)	118.90	122.40	125.33	118.73
Volume Factor	13.33333	13.3333333	13.33333	13.33333

Data entered by: CAL Date: 02/18/2003
Data checked by: RR Date: 2/18/03
FileName: AOPRRS12

ADVANCED TERRA TESTING, INC

Proctor Compaction Test

Composite, , RS1&RS2



- Best Fit Curve
⊗ Actual Data
- Zero Air VoidsCurve @ SG = 2.60

OPTIMUM MOISTURE CONTENT = 10.2 MAXIMUM DRY DENSITY = 126.0
ASTM D 698 C, Rock correction applied? Y

ADVANCED TERRA TESTING, INC.

STANDARD PROCTOR TEST

TOPSOIL

COMPACTION TEST
ASTM D 698 C

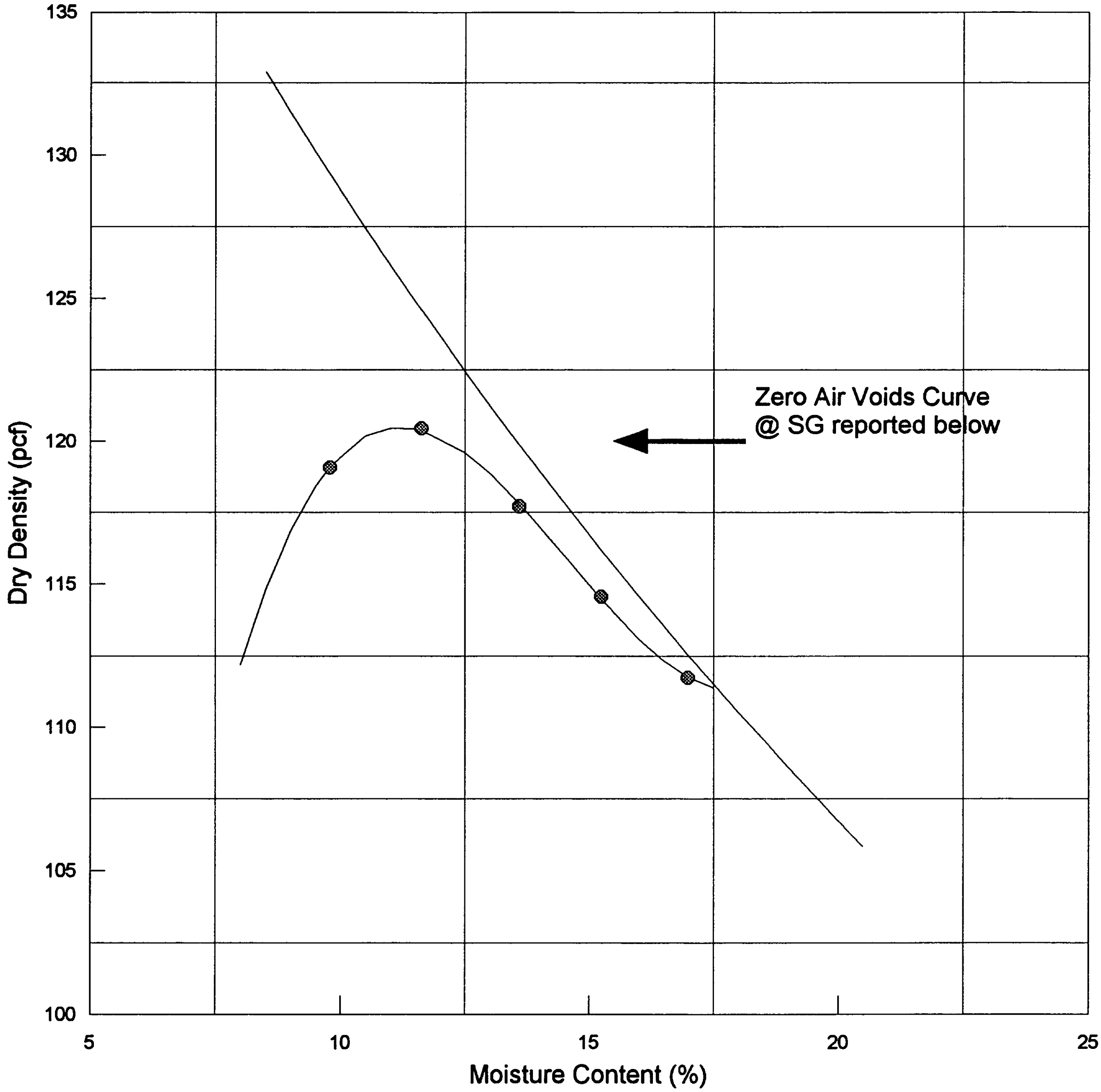
CLIENT:	Agapito Associates	JOB NO.	2452-08
BORING NO.	Composite	DATE SAMPLED	
DEPTH		DATE TESTED	2/13/03
SAMPLE NO.	Topsoil 1,2,3,4,5	LOCATION	Westridge Mine
SOIL DESCR.			

Moisture Determination	1	2	3	4	5
Wt of Moisture added (ml)	400.00	300.00	200.00	100.00	0.00
Wt. of soil & dish (g)	1160.06	1120.68	1000.80	1007.23	811.23
Dry wt. soil & dish (g)	970.38	953.43	865.68	888.65	729.51
Net loss of moisture (g)	189.68	167.25	135.12	118.58	81.72
Wt. of dish (g)	15.22	14.93	15.23	15.47	14.90
Net wt. of dry soil (g)	955.16	938.50	850.45	873.18	714.61
Moisture Content (%)	19.86	17.82	15.89	13.58	11.44
Corrected Moisture Content	16.99	15.24	13.59	11.62	9.79
Density determination					
Wt of soil & mold (lb)	23.81	23.93	24.08	24.16	23.88
Wt. of mold (lb)	14.50	14.50	14.50	14.50	14.50
Net wt. of wet soil (lb)	9.31	9.43	9.58	9.66	9.38
Net wt of dry soil (lb)	7.96	8.18	8.43	8.65	8.54
Dry Density, (pcf)	106.11	109.10	112.45	115.39	113.92
Corrected Dry Density (pcf)	111.73	114.56	117.70	120.45	119.07
Volume Factor	13.33333	13.3333333	13.33333	13.33333	13.33333

Data entered by: RS Date: 02/14/2003
Data checked by: CU Date: 02/14/03
FileName: AOPRTOPC ADVANCED TERRA TESTING, INC.

Proctor Compaction Test

Composite, , Topsoil 1,2,3,4,5



- Best Fit Curve
- Actual Data
- Zero Air VoidsCurve @ SG = 2.60

OPTIMUM MOISTURE CONTENT = 11.2 MAXIMUM DRY DENSITY = 120.5
ASTM D 698 C, Rock correction applied? Y

ADVANCED TERRA TESTING, INC.

DIRECT SHEAR TEST DATA & DATA ANALYSIS

RESIDUAL SOIL

LARGE SCALE INTERNAL DIRECT SHEAR TEST DATA
ASTM D 3080 MODIFIED - 12" x 12" Box

CLIENT:	Agapito Associates	Date:	02-27-03
Project No:	2452-08	Test date:	02-25,26-03
Project:	West Ridge, JN:460-03	Technician:	SR
Interface:	Residual Soil	Shear Rate:	.012"/min
Special conditions:		Test Series:	DS-2

Displacement (inches)	Normal Force 2880 psf Shear Stress (psf)	Normal Force 5760 psf Shear Stress (psf)	Normal Force 8640 psf Shear Stress (psf)
0	0	0	0
0.027	585	1016	1284
0.085	1074	1901	2232
0.145	1388	2439	2867
0.208	1627	2862	3370
0.272	1822	3227	3807
0.338	1974	3525	4184
0.4	2129	3779	4498
0.463	2258	4004	4810
0.526	2378	4218	5084
0.59	2494	4414	5369
0.656	2612	4610	5625
0.72	2718	4791	5872
0.783	2799	4976	6125
0.845	2884	5145	6362
0.91	2969	5291	6600
0.975	3038	5419	6812
1.04	3105	5545	7025
1.102	3176	5665	7201
1.165	3234	5756	7382
1.231	3286	5840	7531
1.297	3332	5932	7689
1.361	3371	6010	7808
1.423	3410	6096	7914
1.486	3445	6154	8034
1.551	3480	6274	8129
1.616	3515	6405	8265
1.683	3525	6505	8386
1.748	3545	6609	8459
1.811	3581	6697	8534
1.873	3610	6765	8608
1.936	3644	6840	8713
2.002	3658	6868	8856

NOTE: The values are not corrected.

Data Entered By: SR — Date: 02-27-03
Data Checked By: KR — Date: 2/27/03
File Name: AODSRDS

Advanced Terra Testing, Inc.

Direct Shear Test West Ridge slope reclamation **Residual Soil** Initial area = 144 in^2 (12" x 12" box) Normal Load = 2880 lb-f	Displacement (inches)	Corrected Area (in^2)	Corrected Normal Stress (psf) @ Normal Force (lb-f) = 2880	Shear Load (lb-f)	Shear Stress (psf)	Internal Friction Angle (deg)
	0	144.000	2880.000	0	0	0.0
	0.027	143.676	2886.495	585	586	11.5
	0.085	142.980	2900.546	1074	1082	20.3
	0.145	142.260	2915.226	1388	1405	25.5
	0.208	141.504	2930.801	1627	1656	29.0
	0.272	140.736	2946.794	1822	1864	31.7
	0.338	139.944	2963.471	1974	2031	33.7
	0.4	139.200	2979.310	2129	2202	35.5
	0.463	138.444	2995.579	2258	2349	37.0
	0.526	137.688	3012.027	2378	2487	38.3
	0.59	136.920	3028.922	2494	2623	39.5
	0.656	136.128	3046.544	2612	2763	40.6
	0.72	135.360	3063.830	2718	2891	41.6
	0.783	134.604	3081.038	2799	2994	42.3
	0.845	133.860	3098.162	2884	3102	42.9
	0.91	133.080	3116.321	2969	3213	43.6
	0.975	132.300	3134.694	3038	3307	44.1
	1.04	131.520	3153.285	3105	3400	44.6
	1.102	130.776	3171.224	3176	3497	45.0
	1.165	130.020	3189.663	3234	3582	45.4
	1.231	129.228	3209.212	3286	3662	45.7
	1.297	128.436	3229.001	3332	3736	45.9
	1.361	127.668	3248.426	3371	3802	46.1
	1.423	126.924	3267.467	3410	3869	46.2
	1.486	126.168	3287.046	3445	3932	46.3
	1.551	125.388	3307.494	3480	3997	46.5
	1.616	124.608	3328.197	3515	4062	46.6
	1.683	123.804	3349.811	3525	4100	46.5
	1.748	123.024	3371.050	3545	4149	46.4
	1.811	122.268	3391.893	3581	4217	46.6
	1.873	121.524	3412.659	3610	4278	46.6
	1.936	120.768	3434.022	3644	4345	46.7
	2.002	119.976	3456.691	3658	4390	46.6

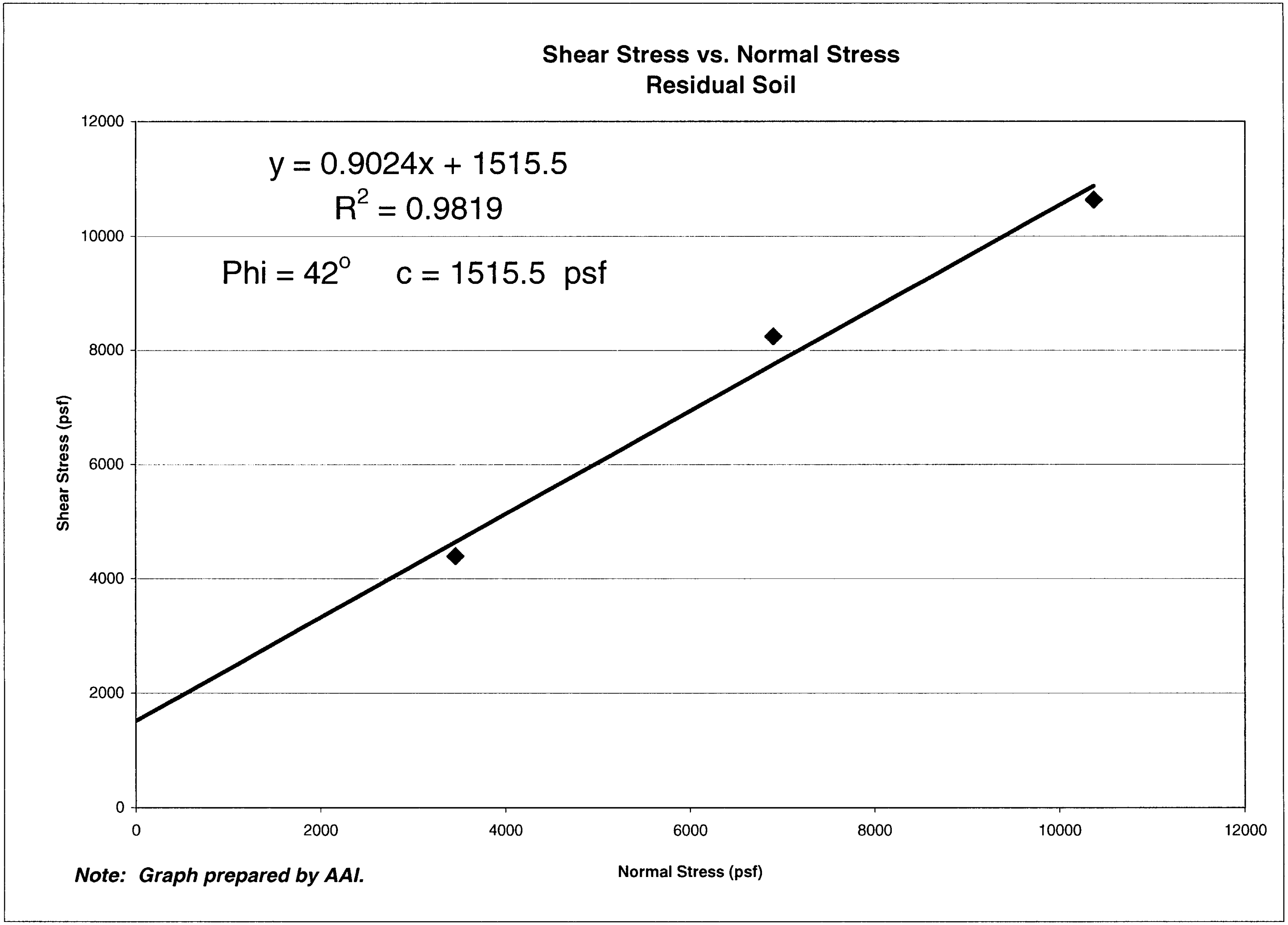
Note: Direct shear test data analysis worksheet prepared by AAI.

Direct Shear Test West Ridge slope reclamation **Residual Soil** Initial area = 144 in^2 (12" x 12" box) Normal Load = 5760 lb-f	Displacement (inches)	Corrected Area (in^2)	Normal Stress (psf) @ Normal Force (lb-f) = 5760	Shear Load (lb-f)	Shear Stress (psf)	Internal Friction Angle (deg)
	0	144.000	5760.000	0	0	0.0
	0.027	143.676	5772.989	1016	1018	10.0
	0.085	142.980	5801.091	1901	1915	18.1
	0.145	142.260	5830.451	2439	2469	22.7
	0.208	141.504	5861.601	2862	2912	26.0
	0.272	140.736	5893.588	3227	3302	28.7
	0.338	139.944	5926.942	3525	3627	30.7
	0.4	139.200	5958.621	3779	3909	32.4
	0.463	138.444	5991.159	4004	4165	33.8
	0.526	137.688	6024.054	4218	4411	35.0
	0.59	136.920	6057.844	4414	4642	36.1
	0.656	136.128	6093.089	4610	4877	37.1
	0.72	135.360	6127.660	4791	5097	38.0
	0.783	134.604	6162.075	4976	5323	38.9
	0.845	133.860	6196.325	5145	5535	39.7
	0.91	133.080	6232.642	5291	5725	40.3
	0.975	132.300	6269.388	5419	5898	40.8
	1.04	131.520	6306.569	5545	6071	41.3
	1.102	130.776	6342.448	5665	6238	41.8
	1.165	130.020	6379.326	5756	6375	42.1
	1.231	129.228	6418.423	5840	6508	42.3
	1.297	128.436	6458.002	5932	6651	42.6
	1.361	127.668	6496.851	6010	6779	42.8
	1.423	126.924	6534.934	6096	6916	43.0
	1.486	126.168	6574.092	6154	7024	43.1
	1.551	125.388	6614.987	6274	7205	43.5
	1.616	124.608	6656.394	6405	7402	43.9
	1.683	123.804	6699.622	6505	7566	44.2
	1.748	123.024	6742.099	6609	7736	44.4
	1.811	122.268	6783.786	6697	7887	44.6
	1.873	121.524	6825.318	6765	8016	44.7
	1.936	120.768	6868.045	6840	8156	44.9
	2.002	119.976	6913.383	6868	8243	44.8

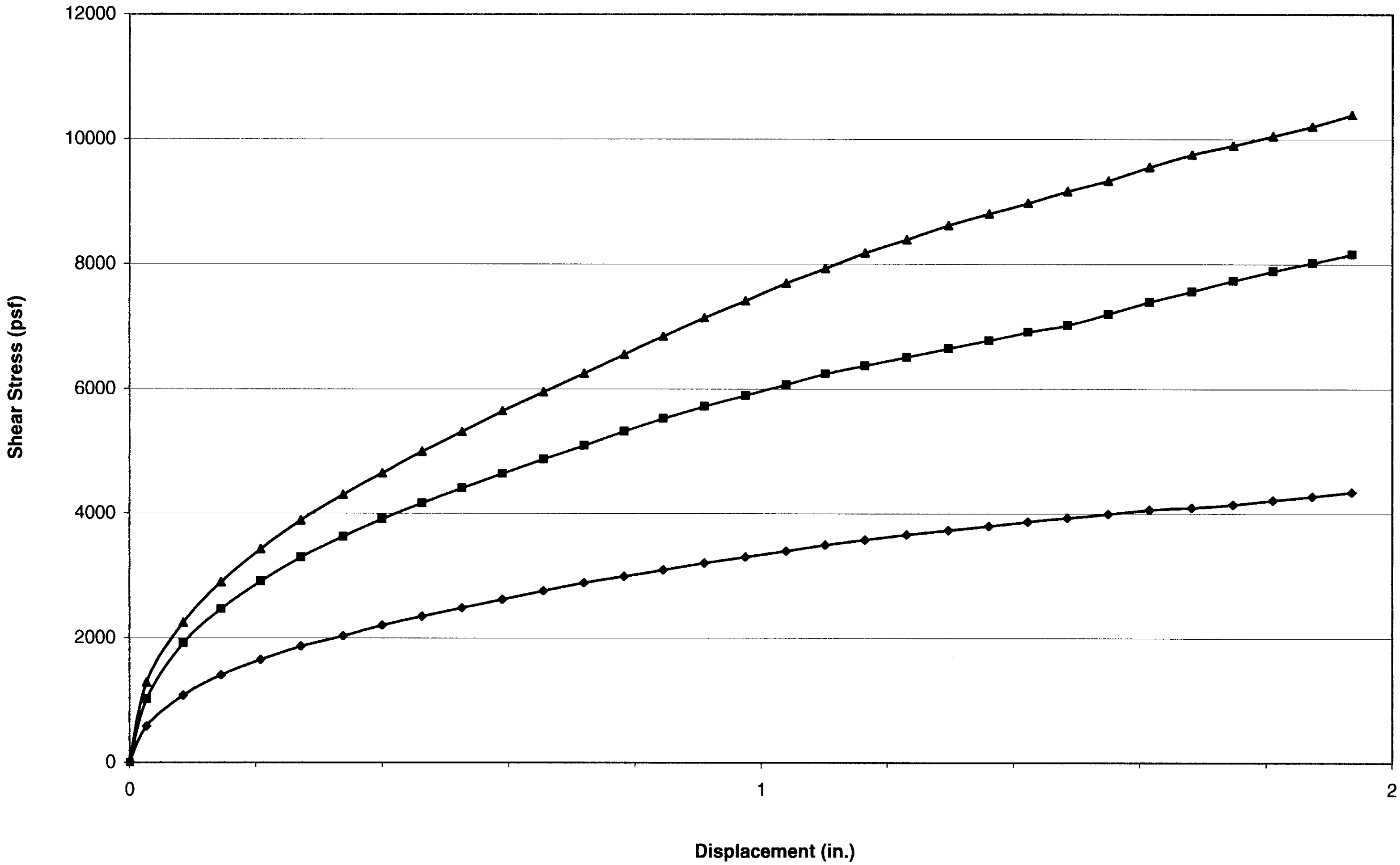
Note: Direct shear test data analysis worksheet prepared by AAI.

Direct Shear Test West Ridge slope reclamation **Residual Soil** Initial area = 144 in^2 (12" x 12" box) Normal Load (lb-f) = 8640	Displacement (inches)	Corrected Area (in^2)	Normal Stress (psf) @ Normal Force (lb-f) = 8640	Shear Load (lb-f)	Shear Stress (psf)	Internal Friction Angle (deg)
	0	144.000	8640.000	0	0	0.0
	0.027	143.676	8659.484	1284	1287	8.4
	0.085	142.980	8701.637	2232	2248	14.4
	0.145	142.260	8745.677	2867	2902	18.2
	0.208	141.504	8792.402	3370	3429	21.0
	0.272	140.736	8840.382	3807	3895	23.3
	0.338	139.944	8890.413	4184	4305	25.2
	0.4	139.200	8937.931	4498	4653	26.7
	0.463	138.444	8986.738	4810	5003	28.2
	0.526	137.688	9036.082	5084	5317	29.4
	0.59	136.920	9086.766	5369	5647	30.6
	0.656	136.128	9139.633	5625	5950	31.6
	0.72	135.360	9191.489	5872	6247	32.6
	0.783	134.604	9243.113	6125	6553	33.5
	0.845	133.860	9294.487	6362	6844	34.4
	0.91	133.080	9348.963	6600	7142	35.2
	0.975	132.300	9404.082	6812	7414	35.9
	1.04	131.520	9459.854	7025	7692	36.6
	1.102	130.776	9513.672	7201	7929	37.1
	1.165	130.020	9568.989	7382	8176	37.6
	1.231	129.228	9627.635	7531	8392	38.0
	1.297	128.436	9687.004	7689	8621	38.4
	1.361	127.668	9745.277	7808	8807	38.7
	1.423	126.924	9802.401	7914	8979	38.9
	1.486	126.168	9861.138	8034	9169	39.2
	1.551	125.388	9922.481	8129	9336	39.3
	1.616	124.608	9984.592	8265	9551	39.6
	1.683	123.804	10049.433	8386	9754	39.8
	1.748	123.024	10113.149	8459	9901	39.9
	1.811	122.268	10175.680	8534	10051	40.0
	1.873	121.524	10237.978	8608	10200	40.1
	1.936	120.768	10302.067	8713	10389	40.2
	2.002	119.976	10370.074	8856	10629	40.5

Note: Direct shear test data analysis worksheet prepared by AAI.


Shear Stress vs. Normal Stress
Residual Soil
y = 0.9024x + 1515.5
R2 = 0.9819
Phi = 42o c = 1515.5 psf
Shear Stress (psf)
Normal Stress (psf)
0
2000
4000
6000
8000
10000
12000
Note: Graph prepared by AAI.

Displacement vs. Shear Stress
Residual Soil



Note: Graph prepared by AAI.

DIRECT SHEAR TEST DATA & DATA ANALYSIS

TOPSOIL

LARGE SCALE INTERNAL DIRECT SHEAR TEST DATA

ASTM D 3080 MODFIED - 12"x12" Box

CLIENT:	Agapito Associates	Date:	02-25-03
Project No:	2452-08	Test date:	02-22&24-03
Project:	West Ridge, JN: 460-03	Technician:	SR
Interface:	Topsoil	Shear Rate:	.012 "/min
Special conditions:		Test Series:	DS-1

Displacement (inches)	Normal Force 2880 psf Shear Stress (psf)	Normal Force 5760 psf Shear Stress (psf)	Normal Force 8640 psf Shear Stress (psf)
0.001	0	0	0
0.023	723	931	1267
0.083	1327	1705	2330
0.145	1671	2163	3027
0.207	1901	2523	3548
0.271	2072	2817	3953
0.335	2223	3074	4307
0.398	2338	3312	4631
0.462	2431	3516	4896
0.527	2516	3689	5170
0.59	2604	3860	5401
0.654	2690	4031	5645
0.717	2784	4183	5879
0.782	2864	4329	6100
0.846	2931	4467	6322
0.911	2995	4582	6520
0.974	3060	4708	6727
1.038	3120	4837	6918
1.102	3180	4954	7063
1.166	3234	5061	7211
1.231	3249	5138	7353
1.296	3321	5254	7489
1.359	3371	5335	7611
1.424	3415	5455	7724
1.489	3444	5511	7823
1.554	3478	5593	7938
1.617	3517	5687	7971
1.682	3537	5757	8079
1.749	3556	5810	8144
1.814	3580	5872	8220
1.877	3596	5950	8293
1.941	3630	6018	8296
2.006	3669	6043	8353
2.072	3721	6083	8378

NOTE: The values are not corrected.

Data Entered By: SR   Date: 02-25-03
Data Checked By: KR   Date: 2/25/03
File Name: AODSTOPS

Advanced Terra Testing, Inc.

Direct Shear Test West Ridge slope reclamation **Topsoil**	Displacement (inches)	Corrected Area (in^2)	Corrected Normal Stress (psf) @ Normal Force (lb-f) = 2880	Shear Load (lb-f)	Shear Stress (psf)	Internal Friction Angle (deg)
Initial area = 144 in^2	0.001	143.988	2880.240	0	0	0.0
(12" x 12" box)	0.023	143.724	2885.531	723	724	14.1
Normal Load = 2880 lb-f	0.083	143.004	2900.059	1327	1336	24.6
	0.145	142.260	2915.226	1671	1691	29.8
	0.207	141.516	2930.552	1901	1934	33.0
	0.271	140.748	2946.543	2072	2120	35.1
	0.335	139.980	2962.709	2223	2287	36.9
	0.398	139.224	2978.797	2338	2418	38.1
	0.462	138.456	2995.320	2431	2528	39.1
	0.527	137.676	3012.290	2516	2632	39.9
	0.59	136.920	3028.922	2604	2739	40.7
	0.654	136.152	3046.007	2690	2845	41.4
	0.717	135.396	3063.015	2784	2961	42.3
	0.782	134.616	3080.763	2864	3064	42.9
	0.846	133.848	3098.440	2931	3153	43.4
	0.911	133.068	3116.602	2995	3241	43.9
	0.974	132.312	3134.410	3060	3330	44.3
	1.038	131.544	3152.709	3120	3415	44.7
	1.102	130.776	3171.224	3180	3502	45.1
	1.166	130.008	3189.958	3234	3582	45.4
	1.231	129.228	3209.212	3249	3620	45.4
	1.296	128.448	3228.700	3321	3723	45.8
	1.359	127.692	3247.815	3371	3802	46.1
	1.424	126.912	3267.776	3415	3875	46.3
	1.489	126.132	3287.984	3444	3932	46.3
	1.554	125.352	3308.443	3478	3995	46.4
	1.617	124.596	3328.518	3517	4065	46.6
	1.682	123.816	3349.486	3537	4114	46.6
	1.749	123.012	3371.378	3556	4163	46.5
	1.814	122.232	3392.892	3580	4218	46.5
	1.877	121.476	3414.008	3596	4263	46.5
	1.941	120.708	3435.729	3630	4330	46.6
	2.006	119.928	3458.075	3669	4405	46.7
	2.072	119.136	3481.064	3721	4498	46.9

Note: Direct shear test data analysis worksheet prepared by AAI.

Direct Shear Test West Ridge slope reclamation	Displacement (inches)	Corrected Area (in^2)	Normal Stress (psf) @ Normal Force (lb-f) = 5760	Shear Load (lb-f)	Shear Stress (psf)	Internal Friction Angle (deg)
Topsoil	0.001	143.988	5760.480	0	0	0.0
Initial area = 144 in^2	0.023	143.724	5771.061	931	933	9.2
(12" x 12" box)	0.083	143.004	5800.117	1705	1717	16.4
Normal Load = 5760 lb-f	0.145	142.260	5830.451	2163	2189	20.4
	0.207	141.516	5861.104	2523	2567	23.3
	0.271	140.748	5893.086	2817	2882	25.5
	0.335	139.980	5925.418	3074	3162	27.4
	0.398	139.224	5957.594	3312	3426	29.1
	0.462	138.456	5990.640	3516	3657	30.4
	0.527	137.676	6024.579	3689	3858	31.5
	0.59	136.920	6057.844	3860	4060	32.5
	0.654	136.152	6092.015	4031	4263	33.5
	0.717	135.396	6126.030	4183	4449	34.3
	0.782	134.616	6161.526	4329	4631	35.1
	0.846	133.848	6196.880	4467	4806	35.8
	0.911	133.068	6233.204	4582	4958	36.3
	0.974	132.312	6268.819	4708	5124	36.9
	1.038	131.544	6305.419	4837	5295	37.5
	1.102	130.776	6342.448	4954	5455	38.0
	1.166	130.008	6379.915	5061	5606	38.4
	1.231	129.228	6418.423	5138	5725	38.7
	1.296	128.448	6457.399	5254	5890	39.1
	1.359	127.692	6495.630	5335	6016	39.4
	1.424	126.912	6535.552	5455	6189	39.9
	1.489	126.132	6575.968	5511	6292	40.0
	1.554	125.352	6616.887	5593	6425	40.2
	1.617	124.596	6657.036	5667	6550	40.4
	1.682	123.816	6698.973	5757	6695	40.7
	1.749	123.012	6742.757	5810	6801	40.8
	1.814	122.232	6785.784	5872	6918	40.9
	1.877	121.476	6828.015	5950	7053	41.1
	1.941	120.708	6871.458	6018	7179	41.2
	2.006	119.928	6916.150	6043	7256	41.1
	2.072	119.136	6962.127	6083	7353	41.1

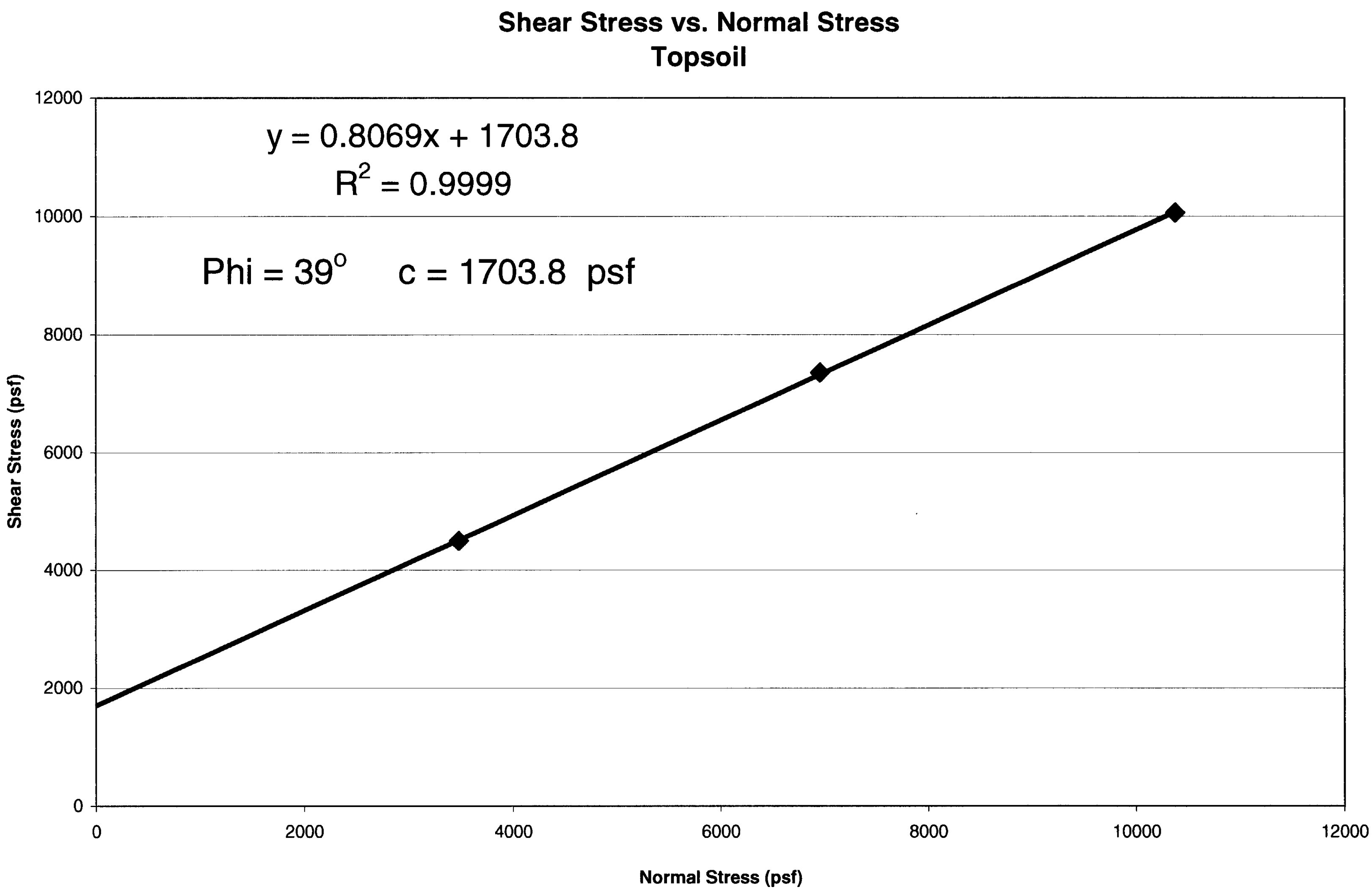
Note: Direct shear test data analysis worksheet prepared by AAI.

Direct Shear Test
West Ridge
slope reclamation
Topsoil

Initial area = 144 in^2
(12" x 12" box)
Normal Load (lb-f) = 8640

Displacement (inches)	Corrected Area (in^2)	Normal Stress (psf) @ Normal Force (lb-f) = 8640	Shear Load (lb-f)	Shear Stress (psf)	Internal Friction Angle (deg)
0.001	143.988	8640.720	0	0	0.0
0.023	143.988	8640.720	1267	1267	8.3
0.083	143.724	8656.592	2330	2334	15.1
0.145	143.004	8700.176	3027	3048	19.2
0.207	142.260	8745.677	3548	3591	22.1
0.271	141.516	8791.656	3953	4022	24.2
0.335	140.748	8839.628	4307	4407	26.0
0.398	139.980	8888.127	4631	4764	27.5
0.462	139.224	8936.390	4896	5064	28.7
0.527	138.456	8985.959	5170	5377	29.9
0.59	137.676	9036.869	5401	5649	30.9
0.654	136.920	9086.766	5645	5937	31.8
0.717	136.152	9138.022	5879	6218	32.8
0.782	135.396	9189.045	6100	6488	33.6
0.846	134.616	9242.289	6322	6763	34.4
0.911	133.848	9295.320	6520	7015	35.0
0.974	133.068	9349.806	6727	7280	35.7
1.038	132.312	9403.229	6918	7529	36.3
1.102	131.544	9458.128	7063	7732	36.8
1.166	130.776	9513.672	7211	7940	37.2
1.231	130.008	9569.873	7353	8144	37.5
1.296	129.228	9627.635	7489	8345	37.9
1.359	128.448	9686.099	7611	8533	38.2
1.424	127.692	9743.445	7724	8710	38.4
1.489	126.912	9803.328	7823	8876	38.6
1.554	126.132	9863.952	7938	9063	38.8
1.617	125.352	9925.330	7971	9157	38.8
1.682	124.596	9985.553	8079	9337	39.0
1.749	123.816	10048.459	8144	9472	39.0
1.814	123.012	10114.135	8220	9622	39.1
1.877	122.232	10178.677	8293	9770	39.2
1.941	121.476	10242.023	8296	9834	39.0
2.006	120.708	10307.188	8353	9965	39.0
2.072	119.928	10374.225	8378	10060	38.9

Note: Direct shear test data analysis worksheet prepared by AAI.



Note: Graph prepared by AAI.

Note: Graph prepared by AAI.

DIRECT SHEAR TEST DATA & DATA ANALYSIS

BACKFILL

LARGE SCALE INTERNAL DIRECT SHEAR TEST DATA

ASTM D 3080 MODIFIED - 12" x 12" Box

CLIENT:	Agapito Associates	Date:	03-10-03
Project No:	2452-08	Test date:	03-07&10-03
Project:	West Ridge, JN: #460-03	Technician:	SR
Interface:	Backfill	Shear Rate:	0.04"/min
Special conditions:		Test Series:	DS-3

Displacement (inches)	Normal Force 2880 psf Shear Stress (psf)	Normal Force 4320 psf Shear Stress (psf)	Normal Force 5760 psf Shear Stress (psf)
0	0	0	0
0.029	1129	1222	1295
0.088	2017	2921	3000
0.153	2442	3814	4047
0.217	2766	4303	4653
0.284	3023	4680	5105
0.349	3226	4981	5467
0.414	3397	5238	5814
0.48	3549	5464	6088
0.548	3674	5670	6350
0.612	3783	5778	6576
0.675	3883	5911	6803
0.741	3958	6038	7003
0.808	4029	6145	7194
0.872	4096	6251	7330
0.937	4162	6374	7472
1.002	4227	6478	7585
1.069	4295	6603	7705
1.132	4360	6729	7788
1.195	4431	6862	7894
1.259	4506	6988	8015
1.325	4570	7122	8105
1.389	4648	7237	8235
1.451	4712	7330	8337
1.515	4785	7350	8442
1.58	4853	7446	8528
1.644	4922	7526	8630
1.707	4989	7607	8766
1.769	5039	7679	8882
1.835	5068	7752	8897
1.896	5123	7825	9000
1.959	5171	7916	9134
2.023	5231	8011	9211
2.088	5276	8079	9272

NOTE: The values are not corrected.

Data Entered By: SR　　Date: 03-10-03
Data Checked By: KR　　Date: 3/10/03
File Name: AODSBF30

Advanced Terra Testing, Inc.

Direct Shear Test West Ridge slope reclamation **Backfill**	Displacement (inches)	Corrected Area (in^2)	Corrected Normal Stress (psf) @ Normal Force (lb-f) = 2880	Shear Load (lb-f)	Shear Stress (psf)	Internal Friction Angle (deg)
Initial area = 144 in^2	0	144.000	2880.000	0	0	0.0
(12" x 12" box)	0.029	143.652	2886.977	1129	1132	21.4
Normal Load = 2880 lb-f	0.088	142.944	2901.276	2017	2032	34.8
	0.153	142.164	2917.194	2442	2474	39.9
	0.217	141.396	2933.039	2766	2817	43.3
	0.284	140.592	2949.812	3023	3096	45.7
	0.349	139.812	2966.269	3226	3323	47.4
	0.414	139.032	2982.910	3397	3518	48.7
	0.48	138.240	3000.000	3549	3697	49.8
	0.548	137.424	3017.813	3674	3850	50.6
	0.612	136.656	3034.773	3783	3986	51.3
	0.675	135.900	3051.656	3883	4114	51.8
	0.741	135.108	3069.544	3958	4218	52.2
	0.808	134.304	3087.920	4029	4320	52.5
	0.872	133.536	3105.679	4098	4419	52.8
	0.937	132.756	3123.927	4162	4515	53.1
	1.002	131.976	3142.390	4227	4612	53.4
	1.069	131.172	3161.650	4295	4715	53.6
	1.132	130.416	3179.978	4360	4814	53.9
	1.195	129.660	3198.519	4431	4921	54.2
	1.259	128.892	3217.578	4506	5034	54.5
	1.325	128.100	3237.471	4570	5137	54.7
	1.389	127.332	3256.997	4648	5256	55.0
	1.451	126.588	3276.140	4712	5360	55.2
	1.515	125.820	3296.137	4785	5476	55.4
	1.58	125.040	3316.699	4853	5589	55.7
	1.644	124.272	3337.196	4922	5703	55.9
	1.707	123.516	3357.622	4989	5816	56.1
	1.769	122.772	3377.969	5039	5910	56.2
	1.835	121.980	3399.902	5068	5983	56.1
	1.896	121.248	3420.428	5123	6084	56.3
	1.959	120.492	3441.888	5171	6180	56.4
	2.023	119.724	3463.967	5231	6292	56.5
	2.088	118.944	3486.683	5276	6387	56.5

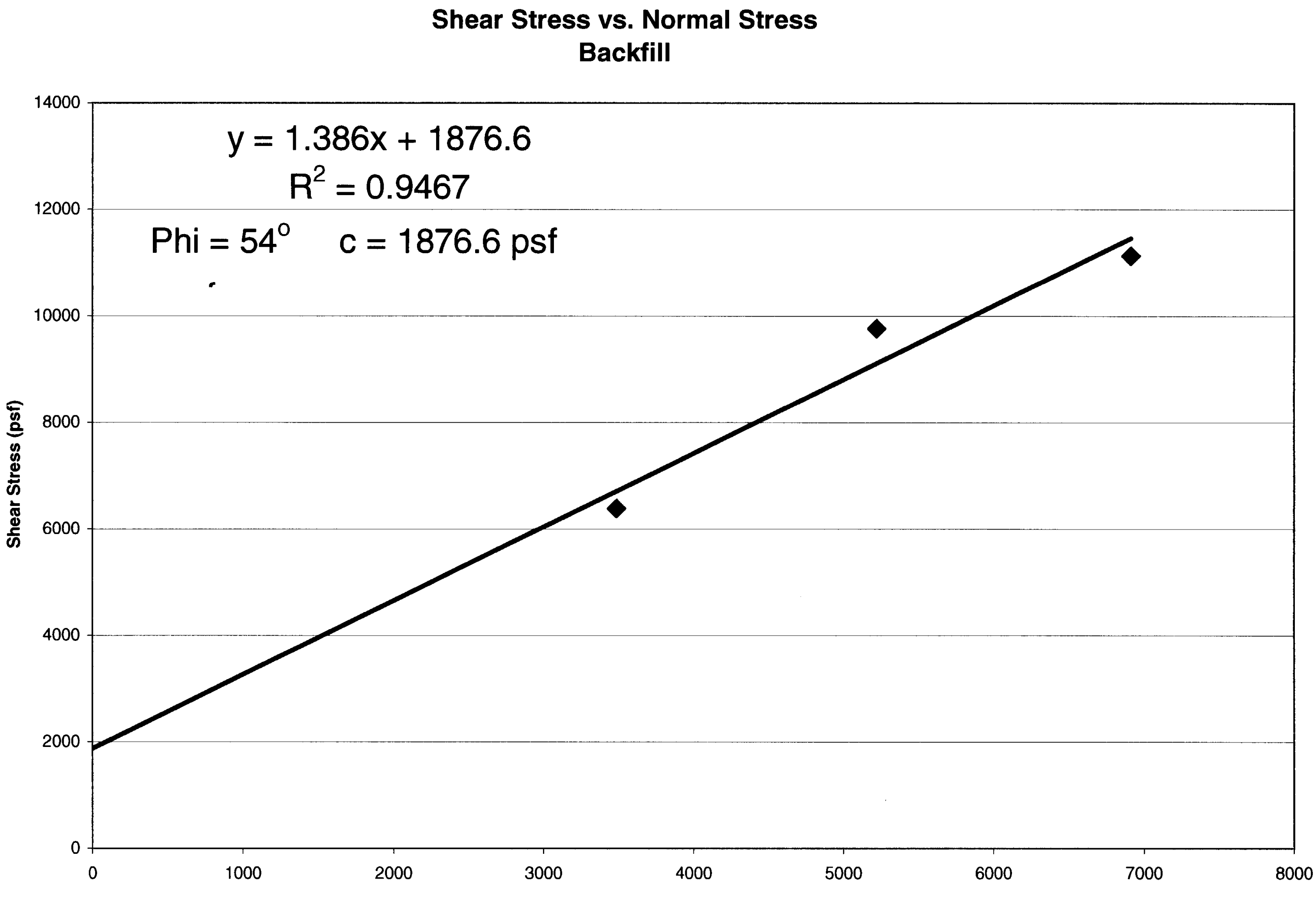
Note: Direct shear test data analysis worksheet prepared by AAI.

Direct Shear Test West Ridge slope reclamation	Displacement (inches)	Corrected Area (in^2)	Normal Stress (psf) @ Normal Force (lb-f) = 4320	Shear Load (lb-f)	Shear Stress (psf)	Internal Friction Angle (deg)
Backfill	0.001	143.988	4320.360	0	0	0.0
Initial area = 144 in^2	0.023	143.724	4328.296	1222	1224	15.8
(12" x 12" box)	0.083	143.004	4350.088	2921	2941	33.9
Normal Load = 4320 lb-f	0.145	142.260	4372.838	3814	3861	41.1
	0.207	141.516	4395.828	4303	4379	44.4
	0.271	140.748	4419.814	4680	4788	46.6
	0.335	139.980	4444.063	4981	5124	48.3
	0.398	139.224	4468.195	5238	5418	49.5
	0.462	138.456	4492.980	5464	5683	50.6
	0.527	137.676	4518.435	5670	5930	51.4
	0.59	136.920	4543.383	5778	6077	51.8
	0.654	136.152	4569.011	5911	6252	52.3
	0.717	135.396	4594.523	6038	6422	52.7
	0.782	134.616	4621.145	6145	6573	53.1
	0.846	133.848	4647.660	6251	6725	53.4
	0.911	133.068	4674.903	6374	6898	53.7
	0.974	132.312	4701.614	6478	7050	54.0
	1.038	131.544	4729.064	6603	7228	54.4
	1.102	130.776	4756.836	6729	7409	54.7
	1.166	130.008	4784.936	6862	7601	55.1
	1.231	129.228	4813.817	6988	7787	55.4
	1.296	128.448	4843.049	7122	7984	55.8
	1.359	127.692	4871.723	7237	8161	56.1
	1.424	126.912	4901.664	7330	8317	56.2
	1.489	126.132	4931.976	7350	8391	56.1
	1.554	125.352	4962.665	7446	8554	56.3
	1.617	124.596	4992.777	7526	8698	56.4
	1.682	123.816	5024.230	7607	8847	56.6
	1.749	123.012	5057.068	7679	8989	56.6
	1.814	122.232	5089.338	7752	9133	56.7
	1.877	121.476	5121.012	7825	9276	56.8
	1.941	120.708	5153.594	7916	9443	56.9
	2.006	119.928	5187.112	8011	9619	57.1
	2.072	119.136	5221.595	8079	9765	57.1

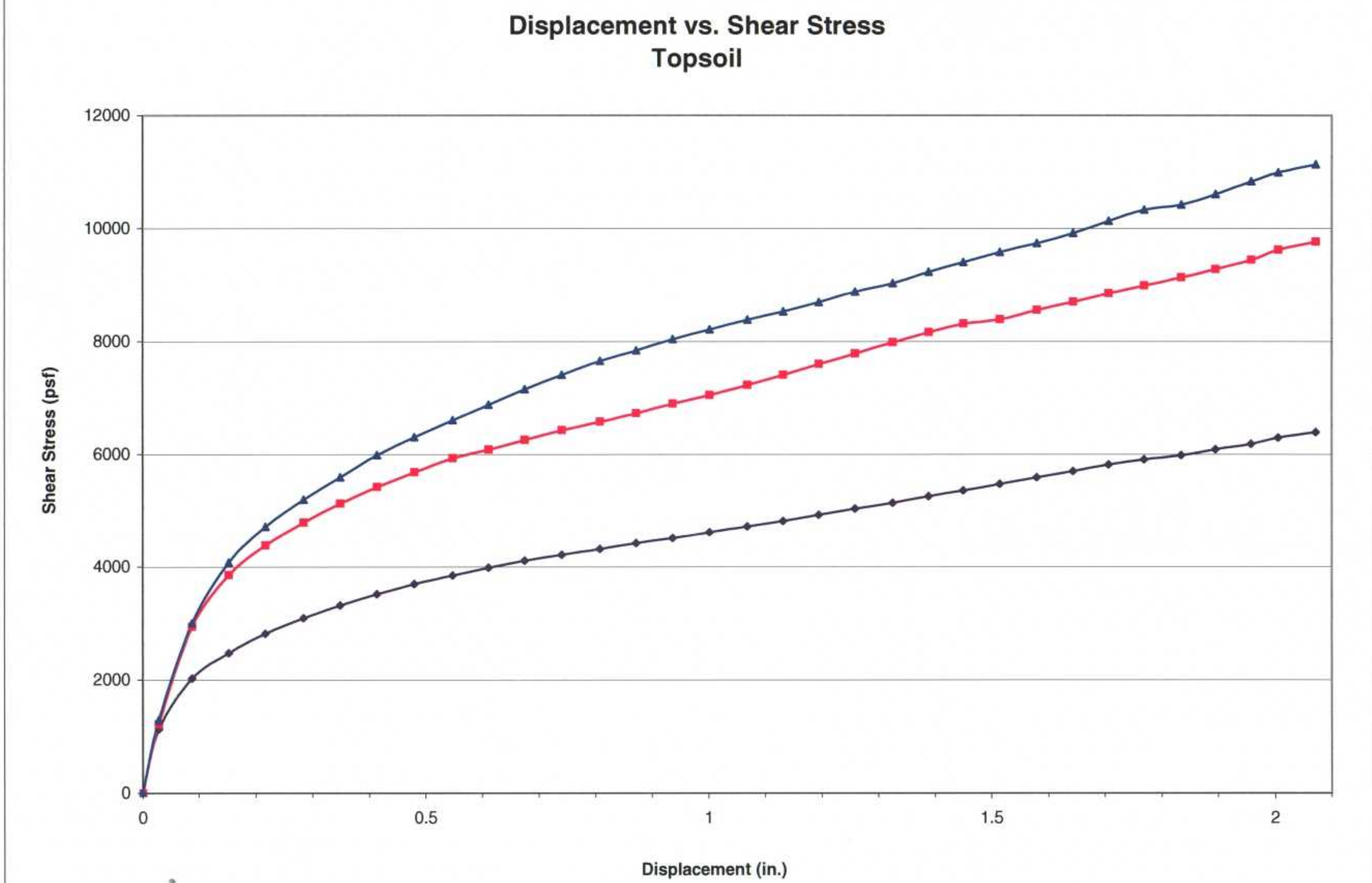
Note: Direct shear test data analysis worksheet prepared by AAI.

Direct Shear Test West Ridge slope reclamation **Backfill** Initial area = 144 in^2 (12" x 12" box) Normal Load (lb-f) = 5760	Displacement (inches)	Corrected Area (in^2)	Normal Stress (psf) @ Normal Force (lb-f) = 5760	Shear Load (lb-f)	Shear Stress (psf)	Internal Friction Angle (deg)
	0.001	143.988	5760.480	0	0	0.0
	0.023	143.988	5760.480	1295	1295	12.7
	0.083	143.724	5771.061	3000	3006	27.5
	0.145	143.004	5800.117	4047	4075	34.9
	0.207	142.260	5830.451	4653	4710	38.6
	0.271	141.516	5861.104	5105	5195	41.1
	0.335	140.748	5893.086	5467	5593	42.9
	0.398	139.980	5925.418	5814	5981	44.5
	0.462	139.224	5957.594	6088	6297	45.6
	0.527	138.456	5990.640	6350	6604	46.7
	0.59	137.676	6024.579	6576	6878	47.5
	0.654	136.920	6057.844	6803	7155	48.3
	0.717	136.152	6092.015	7003	7407	49.0
	0.782	135.396	6126.030	7194	7651	49.6
	0.846	134.616	6161.526	7330	7841	49.9
	0.911	133.848	6196.880	7472	8039	50.3
	0.974	133.068	6233.204	7585	8208	50.6
	1.038	132.312	6268.819	7705	8386	50.9
	1.102	131.544	6305.419	7788	8525	51.0
	1.166	130.776	6342.448	7894	8692	51.2
	1.231	130.008	6379.915	8015	8878	51.5
	1.296	129.228	6418.423	8105	9031	51.6
	1.359	128.448	6457.399	8235	9232	51.9
	1.424	127.692	6495.630	8337	9402	52.1
	1.489	126.912	6535.552	8442	9579	52.3
	1.554	126.132	6575.968	8528	9736	52.4
	1.617	125.352	6616.887	8630	9914	52.5
	1.682	124.596	6657.036	8766	10131	52.8
	1.749	123.816	6698.973	8882	10330	53.0
	1.814	123.012	6742.757	8897	10415	52.8
	1.877	122.232	6785.784	9000	10603	53.0
	1.941	121.476	6828.015	9134	10828	53.2
	2.006	120.708	6871.458	9211	10988	53.3
	2.072	119.928	6916.150	9272	11133	53.3

Note: Direct shear test data analysis worksheet prepared by AAI.



Note: Graph prepared by AAI.



Note: Graph prepared by AAI.

SOIL CHEMISTRY TESTS

BACKFILL & TOPSOIL

Colorado Analytical
Laboratories, Inc.

LABORATORY ANALYSIS REPORT

REPORT TO: KERRY REPOLA

LAB NO: 12419

DATE RCVD: 1/17/03

COMPANY: ADVANCED TERRA TESTING, INC.
833 PARFET STREET
LAKEWOOD, CO 80215

REPORTED: 2/7/03

P.O. #: VERBAL

PROJECT: 460-03 WESTRIDGE MINE AGAPITO ASSOCIATES

PARAMETER	METHOD REFERENCE	MIN. REPORTING LIMIT	UNITS
TEXTURE-HYDROMETER	USDA	1	PERCENT
pH (PASTE)	SSSA	0.1	UNITS
ELECTRICAL CONDUCTIVITY	SSSA	0.1	MMHOS/CM
TOTAL ORGANIC CARBON	WESTERN STATES	0.01	PERCENT
SODIUM ADSORPTION RATIO	USDA	0.1	UNITS
PERCENT SATURATION	SSSA	0.1	PERCENT
SOLUBLE SELENIUM	SSSA	0.05	PPM
AVAILABLE BORON	SSSA	0.1	PPM
$CaCO_3$	WESTERN STATES	0.1	%
K-FACTOR (K_f)	USDA	0.1	UNITS

REFERENCES:

SSSA = "METHODS OF SOIL ANALYSIS; PART 3"; SOIL SCIENCE SOCIETY OF AMERICA"; AGRONOMY; 2nd EDITION, 1986; A. KLUTE

ASA2 = "METHODS OF SOIL ANALYSIS, PART 2"; ASA No. 9 AMERICAN SOCIETY of AGRONOMY; 2nd EDITION, 1982; A. L. PAGE

USDA60 = "DIAGNOSIS and IMPROVEMENT of SALINE & ALKALI SOILS"; USDA HANDBOOK 60; UNITED STATES SALINITY LABORATORY STAFF; 2nd EDITION, 1969; L.A. RICHARDS

Shane Neil
ANALYSIS SUPERVISED BY

Stanley Walker
DATA APPROVED FOR RELEASE BY

240 South Main Street / Brighton, Colorado 80601-0507 / 303-659-2313
Mailing Address: P.O. Box 507 / Brighton, Colorado 80601-0507 / Fax: 303-659-2315

Colorado Analytical
Laboratories, Inc.

ADVANCED TERRA TESTING, INC.
KERRY REPOLA
PROJECT: 460-03 WESTRIDGE MINE AGAPITO ASSOCIATES

	HYDROMETER RESULTS-TEXTURE			USDA	
SAMPLE ID	SAND (%)	SILT (%)	CLAY (%)	TEXTURE	% SATURATION
BACKFILL COMPOSITE	56	30	14	SANDY LOAM	24.3
TOPSOIL COMPOSITE	44	36	20	LOAM	37.7

BDL = BELOW DETECTION LIMIT
PPM = PARTS PER MILLION
MEQ/100G = MILLIEQUIVALENT PER 100 GRAMS
MEQ/L = MILLIEQUIVALENT PER LITER

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SAMPLE ID	pH-paste (units)	Elec. Conductivity (mmhos/cm)	Soluble Selenium (ppm)	Available Boron (ppm)	Total Organic Carbon (%)
BACKFILL COMPOSITE	7.8	6.84	0.11	0.98	0.5
TOPSOIL COMPOSITE	7.8	0.68	0.11	0.47	1.2

BDL = BELOW DETECTION LIMIT
PPM = PARTS PER MILLION
MEQ/100G = MILLIEQUIVALENT PER 100 GRAMS
MEQ/L = MILLIEQUIVALENT PER LITER

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			<---	SOLUBLE	--->	
	LIME		CALCIUM	MAGNESIUM	SODIUM	SAR
SAMPLE ID	(% CaCO3 EQUIV.)	K_f(UNITS)	(meq/L)	(meq/L)	(meq/L)	(UNITS)
BACKFILL COMPOSITE	19.2	0.32	96.7	19.7	62.9	8.2
TOPSOIL COMPOSITE	3.3	0.38	14.8	4.0	2.3	0.8

BDL = BELOW DETECTION LIMIT
PPM = PARTS PER MILLION
MEQ/100G = MILLIEQUIVALENT PER 100 GRAMS
MEQ/L = MILLIEQUIVALENT PER LITER

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Mailing Address: P.O. Box 507 / Brighton, Colorado 80601-0507 / Fax: 303-659-2315

Colorado Analytical Laboratories, Inc.

LABORATORY ANALYSIS REPORT

REPORT TO: KERRY REPOLA

LAB NO: 12419

DATE RCVD: 1/17/03

REPORTED: 2/7/03

BILL TO: ADVANCED TERRA TESTING
833 PARFET STREET
LAKEWOOD, CO 80215

P.O. #: VERBAL

PROJECT: 460-03 WESTRIDGE MINE AGAPITO ASSOCIATES

PARAMETER	METHOD REFERENCE	MIN. REPORTING LIMIT	UNITS
ACID/BASE POTENTIAL	SOBEK:		
NEUTRALIZATION POTENTIAL	method 3.2.3	0.1	T/1000T
TOTAL SULFUR	method 3.2.4	0.1	T/1000T

T/1000T = TONS CaCO3 per 1000 TONS SAMPLE

REFERENCES:
SOBEK = "FIELD & LABORATORY METHODS APPLICABLE TO OVERBURDENS & MINESOILS"; EPA-600/2-78-054; USEPA; 1978; A. A. SOBEK

ANALYSIS SUPERVISED BY

DATA APPROVED FOR RELEASE BY

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Mailing Address: P.O. Box 507 / Brighton, Colorado 80601-0507 / Fax: 303-659-2315

Colorado Analytical
Laboratories, Inc.

KERRY REPOLA
ADVANCED TERRA TESTING
LAB NO: 12419
460-03 WESTRIDGE MINE AGAPITO ASSOCIATES
2/7/03

	TOTAL SULFUR		TOTAL CARBONATE	pH
SAMPLE ID	(PERCENT)	(T/1000T)	(NEUTRALIZATION POTENTIAL T/1000T)	(UNITS)
BACKFILL COMPOSITE	0.303	9.5	191.8	7.8
TOPSOIL COMPOSITE	0.044	1.4	33.3	7.8

*NON TOXIC pH value

*SAMPLES ARE CONSIDERED NON TOXIC IF THE pH IS ABOVE 4.0 AND THE ACID BASE POTENIAL BASED ON THE PYRITIC SULFUR (OR TOTAL SULFUR) IS GREATER THAN -4. ABP BASED ON TOTAL SULFUR REPRESENTS A WORST CASE CONDITION

NOTE: NON TOXIC MEANS NON ACID FORMING.
TOXIC MEANS POTENTIALLY ACID FORMING.

240 South Main Street / Brighton, Colorado 80601-0507 / 303-659-2313
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ADVANCED TERRA TESTING
LAB NO: 12419
460-03 WESTRIDGE MINE AGAPITO ASSOCIATES
2/7/03

SAMPLE ID	TOTAL SULFUR ACID BASE POTENTIAL (T/1000T)	COMMENT*
BACKFILL COMPOSITE	182.3	NON TOXIC
TOPSOIL COMPOSITE	31.9	NON TOXIC

*SAMPLES ARE CONSIDERED NON TOXIC IF THE pH IS ABOVE 4.0 AND THE ACID BASE POTENIAL BASED ON THE PYRITIC SULFUR (OR TOTAL SULFUR) IS GREATER THAN -4. ABP BASED ON TOTAL SULFUR REPRESENTS A WORST CASE CONDITION

NOTE: NON TOXIC MEANS NON ACID FORMING.
TOXIC MEANS POTENTIALLY ACID FORMING.

240 South Main Street / Brighton, Colorado 80601-0507 / 303-659-2313
Mailing Address: P.O. Box 507 / Brighton, Colorado 80601-0507 / Fax: 303-659-2315

Colorado Analytical Laboratories, Inc.

KERRY REPOLA
ADVANCED TERRA TESTING
LAB NO: 12419
460-03 WESTRIDGE MINE AGAPITO ASSOCIATES
2/7/03

SAMPLE ID	PYRITIC SULFUR (PERCENT)	PYRITIC SULFUR (T/1000T)	PYRITIC SULFUR ACID BASE POTENTIAL (T/1000T)	COMMENT
BACKFILL COMPOSITE	-	-	-	NON TOXIC-based on TS
TOPSOIL COMPOSITE	-	-	-	NON TOXIC-based on TS

*SAMPLES ARE CONSIDERED NON TOXIC IF THE pH IS ABOVE 4.0 AND THE ACID BASE POTENIAL BASED ON THE PYRITIC SULFUR (OR TOTAL SULFUR) IS GREATER THAN -4. ABP BASED ON TOTAL SULFUR REPRESENTS A WORST CASE CONDITION

NOTE: NON TOXIC MEANS NON ACID FORMING.
TOXIC MEANS POTENTIALLY ACID FORMING.

240 South Main Street / Brighton, Colorado 80601-0507 / 303-659-2313
Mailing Address: P.O. Box 507 / Brighton, Colorado 80601-0507 / Fax: 303-659-2315

CORROSION TEST SUMMARY

Client: Agapito Associates
Location: Project #460-03

Job Number: 2452-08
Date Tested: 01-22-03 SJG

Sample ID	Temperature (deg C)	pH
Composite Backfill 1,2,3,4,5	25	7.9

ADVANCED TERRA TESTING, inc

Data entry SR
Checked by: OPM
FileName: AOZ01234

Date: 01/23/2003
Date: 01/27/03

APPENDIX B

XSTABL SLOPE STABILITY
OUTPUT FILES

STATIC ANALYSIS OF EXISTING SLOPE

(XSTABL Output File: 30012R4S.opt)

XSTABL File: 30012R4S   3-10-**   17:01

```
******************************************
*              X S T A B L               *
*                                        *
*       Slope Stability Analysis         *
*              using the                 *
*           Method of Slices             *
*                                        *
*         Copyright (C) 1992 á 98        *
*   Interactive Software Designs, Inc.   *
*        Moscow, ID 83843, U.S.A.        *
*                                        *
*          All Rights Reserved           *
*                                        *
*  Ver. 5.202                96 á 1647   *
******************************************
```

Problem Description : Andalex/West_Ridge/March_03

SEGMENT BOUNDARY COORDINATES

10 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	105.2	37.0	105.2	1
2	37.0	105.2	51.0	115.0	1
3	51.0	115.0	83.2	115.0	1
4	83.2	115.0	100.5	136.0	2
5	100.5	136.0	130.2	136.0	2
6	130.2	136.0	134.8	151.0	2
7	134.8	151.0	142.6	178.6	4
8	142.6	178.6	150.1	200.0	5
9	150.1	200.0	286.2	288.0	5
10	286.2	288.0	298.4	288.0	5

4 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	142.6	178.6	288.6	278.0	5
2	288.6	278.0	298.4	278.0	5
3	134.8	151.0	298.4	151.0	2
4	83.2	115.0	298.4	115.0	1

ISOTROPIC Soil Parameters

5 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	155.0	155.0	111168.0	45.00	.000	.0	0
2	78.6	78.6	14112.0	35.00	.000	.0	0
3	138.0	138.0	1877.0	54.00	.000	.0	0
4	155.5	155.5	111168.0	45.00	.000	.0	0
5	134.0	134.0	1515.0	42.00	.000	.0	0

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface is CIRCULAR, with a radius of 190.04 feet

Center at x = 108.74 ; y = 303.32 ; Seg. Length = 18.00 feet

The CIRCULAR failure surface was estimated by
the following 19 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	83.20	115.00
2	101.13	113.43
3	119.13	113.56
4	137.04	115.39
5	154.69	118.91
6	171.93	124.09
7	188.60	130.87
8	204.56	139.20
9	219.66	149.00
10	233.76	160.19
11	246.74	172.66
12	258.48	186.30
13	268.88	200.99
14	277.84	216.60
15	285.29	232.99
16	291.15	250.01
17	295.38	267.50
18	297.93	285.32
19	298.06	288.00

****
SELECTED METHOD OF ANALYSIS: Spencer (1973)
****

****
SUMMARY OF INDIVIDUAL SLICE INFORMATION
****

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	91.85	114.24	11.26	17.30	-5.01	50.52	16311.
2	100.81	113.46	22.54	.63	-5.01	.00	1190.
3	110.13	113.49	22.51	18.00	.42	.00	33911.
4	124.66	114.13	21.87	11.07	5.85	.00	19771.
5	131.69	114.85	26.02	2.99	5.85	72.95	6142.
6	133.99	115.08	33.29	1.61	5.85	72.95	4222.
7	135.92	115.28	39.68	2.24	5.85	74.22	7652.
8	139.82	115.95	52.81	5.56	11.28	74.22	30693.
9	146.35	117.25	72.05	7.50	11.28	70.69	58386.
10	152.39	118.46	83.03	4.59	11.28	32.89	42774.
11	163.31	121.50	87.04	17.24	16.71	32.89	172903.
12	180.27	127.48	92.02	16.67	22.13	32.89	183879.
13	196.58	135.04	95.02	15.96	27.56	32.89	189058.
14	212.11	144.10	95.99	15.10	32.99	32.89	188427.
15	220.92	150.00	95.79	2.52	38.42	32.89	32205.
16	227.97	155.59	94.75	11.58	38.42	32.89	147063.
17	240.25	166.42	91.87	12.98	43.85	32.89	159796.
18	252.61	179.48	86.80	11.74	49.28	32.89	136590.
19	263.68	193.64	79.80	10.40	54.71	32.89	111198.
20	273.36	208.80	70.90	8.96	60.14	32.89	85158.
21	281.57	224.79	60.21	7.45	65.56	32.89	60075.
22	285.75	234.31	53.40	.91	70.99	32.89	6506.
23	287.40	239.11	48.89	2.40	70.99	.00	15722.
24	289.88	246.30	41.70	2.55	70.99	.00	14264.
25	293.27	258.76	29.24	4.23	76.42	.00	16559.
26	296.13	272.75	15.25	1.50	81.85	.00	3071.
27	297.41	281.66	6.34	1.05	81.85	.00	891.
28	297.99	286.66	1.34	.13	87.28	.00	23.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	24.9298	9.3275	10.9909
3	25.6287	9.4009	9.3275
4	25.5933	-----	9.4009
4	25.6110	9.3990	-----
5	25.5942	9.3972	9.3990
6	25.5946	9.3973	9.3972

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	8517.4	111168.0	45.00	0.	0.	0.	.00
2	9572.4	111168.0	45.00	0.	0.	0.	.00
3	7829.5	111168.0	45.00	0.	0.	0.	.00
4	6185.1	111168.0	45.00	0.	0.	0.	.00
5	6453.8	111168.0	45.00	0.	0.	0.	.00
6	3116.3	14112.0	35.00	0.	0.	0.	.00
7	3906.1	14112.0	35.00	0.	0.	0.	.00
8	5523.4	14112.0	35.00	0.	0.	0.	.00
9	7634.6	14112.0	35.00	0.	0.	0.	.00

10	9065.5	14112.0	35.00	0.	0.	0.	.00
11	9109.4	14112.0	35.00	0.	0.	0.	.00
12	9362.9	14112.0	35.00	0.	0.	0.	.00
13	9402.5	14112.0	35.00	0.	0.	0.	.00
14	9235.9	14112.0	35.00	0.	0.	0.	.00
15	8770.7	14112.0	35.00	0.	0.	0.	.00
16	8968.8	1515.0	42.00	0.	0.	0.	.00
17	8120.9	1515.0	42.00	0.	0.	0.	.00
18	7103.9	1515.0	42.00	0.	0.	0.	.00
19	5968.9	1515.0	42.00	0.	0.	0.	.00
20	4755.3	1515.0	42.00	0.	0.	0.	.00
21	3510.5	1515.0	42.00	0.	0.	0.	.00
22	2579.0	1515.0	42.00	0.	0.	0.	.00
23	2348.6	1515.0	42.00	0.	0.	0.	.00
24	1981.3	1515.0	42.00	0.	0.	0.	.00
25	998.3	1515.0	42.00	0.	0.	0.	.00
26	200.2	1515.0	42.00	0.	0.	0.	.00
27	-40.1	1515.0	42.00	0.	0.	0.	.00
28	-240.4	1515.0	42.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	91.85	8517.4	942.8	.0	12736.2
2	100.81	9572.4	1889.9	.0	12848.5
3	110.13	7829.5	1884.0	.0	12663.0
4	124.66	6185.1	1785.9	.0	12488.0
5	131.69	6453.8	2057.0	.0	12516.6
6	133.99	3116.3	2616.3	.0	1733.9
7	135.92	3906.1	3422.7	.0	1792.8
8	139.82	5523.4	5516.0	.0	1913.3
9	146.35	7634.6	7784.8	.0	2070.6
10	152.39	9065.5	9322.7	.0	2177.2
11	163.31	9109.4	10029.0	.0	2180.5
12	180.27	9362.9	11028.3	.0	2199.4
13	196.58	9402.5	11848.0	.0	2202.3
14	212.11	9235.9	12480.8	.0	2189.9
15	220.92	8770.7	12780.2	.0	2155.2
16	227.97	8968.8	12697.1	.0	1020.6
17	240.25	8120.9	12310.2	.0	939.3
18	252.61	7103.9	11631.7	.0	841.9
19	263.68	5968.9	10692.6	.0	733.1
20	273.36	4755.3	9501.2	.0	616.9
21	281.57	3510.5	8068.2	.0	497.6
22	285.75	2579.0	7155.3	.0	408.3
23	287.40	2348.6	6551.0	.0	386.2
24	289.88	1981.3	5587.6	.0	351.1
25	293.27	998.3	3918.8	.0	256.9
26	296.13	200.2	2043.2	.0	180.4
27	297.41	-40.1	849.4	.0	157.4
28	297.99	-240.4	179.4	.0	138.2

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	100.50	25.59	258630.	4.90	22.52	.218
2	101.13	25.59	268189.	5.08	22.57	.225
3	119.13	25.59	519773.	9.06	22.44	.404
4	130.20	25.59	665288.	10.79	21.31	.506
5	133.19	25.59	704542.	11.28	30.74	.367
6	134.80	25.59	707074.	11.85	35.83	.331
7	137.04	25.59	710526.	12.63	43.52	.290
8	142.60	25.59	715536.	14.09	62.10	.227
9	150.10	25.59	720095.	16.09	82.00	.196
10	154.69	25.59	721975.	17.33	84.05	.206
11	171.93	25.59	711394.	20.70	90.03	.230
12	188.60	25.59	681645.	22.83	94.02	.243
13	204.56	25.59	633776.	23.84	96.01	.248
14	219.66	25.59	570060.	23.79	95.97	.248
15	222.18	25.59	556644.	23.57	95.60	.247
16	233.76	25.59	478389.	23.49	93.91	.250
17	246.74	25.59	379624.	22.53	89.83	.251
18	258.48	25.59	283130.	20.83	83.78	.249
19	268.88	25.59	194349.	18.41	75.81	.243
20	277.84	25.59	118173.	15.32	66.00	.232
21	285.29	25.59	58493.	11.58	54.42	.213
22	286.20	25.59	51356.	10.83	52.37	.207
23	288.60	25.59	34239.	8.98	45.40	.198
24	291.15	25.59	18951.	7.54	37.99	.198
25	295.38	25.59	787.	-12.58	20.50	-.614
26	296.88	25.59	-1242.	6.19	10.00	.619
27	297.93	25.59	-733.	1.31	2.68	.487
28	298.06	.00	0.	1.38	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 6308.58 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 3037.28 (psf)

Total Length of failure surface = 308.68 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 9.397

Total shear strength available
along specified failure surface = 881.04E+04 lb

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  For the specified surface, the analysis computed the following:

     Negative (tensile) Normal Effective Force =  1 slices
     Negative (tensile) Interslice Force       =  2 slices
     Unreasonable Location of Interslice Force =  1 slices

  In view of these errors, the computed FOS may be UNREASONABLE!
******************************************************************
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PSEUDOSTATIC ANALYSIS OF EXISTING SLOPE

(XSTABL Output File 300124SP.opt)

XSTABL File: 300124SP   3-11-**   7:45

```
****************************************
*              X S T A B L             *
*                                      *
*       Slope Stability Analysis       *
*             using the                *
*          Method of Slices            *
*                                      *
*       Copyright (C) 1992 á 98        *
*   Interactive Software Designs, Inc. *
*       Moscow, ID 83843, U.S.A.       *
*                                      *
*          All Rights Reserved         *
*                                      *
*  Ver. 5.202               96 á 1647  *
****************************************
```

Problem Description : Andalex/West_Ridge/March_03

SEGMENT BOUNDARY COORDINATES
----

10 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	105.2	37.0	105.2	1
2	37.0	105.2	51.0	115.0	1
3	51.0	115.0	83.2	115.0	1
4	83.2	115.0	100.5	136.0	2
5	100.5	136.0	130.2	136.0	2
6	130.2	136.0	134.8	151.0	2
7	134.8	151.0	142.6	178.6	4
8	142.6	178.6	150.1	200.0	5
9	150.1	200.0	286.2	288.0	5
10	286.2	288.0	298.4	288.0	5

4 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	142.6	178.6	288.6	278.0	5
2	288.6	278.0	298.4	278.0	5
3	134.8	151.0	298.4	151.0	2
4	83.2	115.0	298.4	115.0	1

ISOTROPIC Soil Parameters
----

5 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	155.0	155.0	111168.0	45.00	.000	.0	0
2	78.6	78.6	14112.0	35.00	.000	.0	0
3	138.0	138.0	1877.0	54.00	.000	.0	0
4	155.5	155.5	111168.0	45.00	.000	.0	0
5	134.0	134.0	1515.0	42.00	.000	.0	0

A horizontal earthquake loading coefficient
of .070 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface is CIRCULAR, with a radius of 190.04 feet

Center at x = 108.74 ; y = 303.32 ; Seg. Length = 18.00 feet

The CIRCULAR failure surface was estimated by
the following 19 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	83.20	115.00
2	101.13	113.43
3	119.13	113.56
4	137.04	115.39
5	154.69	118.91
6	171.93	124.09
7	188.60	130.87
8	204.56	139.20
9	219.66	149.00
10	233.76	160.19
11	246.74	172.66
12	258.48	186.30
13	268.88	200.99
14	277.84	216.60
15	285.29	232.99
16	291.15	250.01
17	295.38	267.50
18	297.93	285.32
19	298.06	288.00

****

SELECTED METHOD OF ANALYSIS: Spencer (1973)

****

****

SUMMARY OF INDIVIDUAL SLICE INFORMATION

****

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	91.85	114.24	11.26	17.30	-5.01	50.52	16311.
2	100.81	113.46	22.54	.63	-5.01	.00	1190.
3	110.13	113.49	22.51	18.00	.42	.00	33911.
4	124.66	114.13	21.87	11.07	5.85	.00	19771.
5	131.69	114.85	26.02	2.99	5.85	72.95	6142.
6	133.99	115.08	33.29	1.61	5.85	72.95	4222.
7	135.92	115.28	39.68	2.24	5.85	74.22	7652.
8	139.82	115.95	52.81	5.56	11.28	74.22	30693.
9	146.35	117.25	72.05	7.50	11.28	70.69	58386.
10	152.39	118.46	83.03	4.59	11.28	32.89	42774.
11	163.31	121.50	87.04	17.24	16.71	32.89	172903.
12	180.27	127.48	92.02	16.67	22.13	32.89	183879.
13	196.58	135.04	95.02	15.96	27.56	32.89	189058.
14	212.11	144.10	95.99	15.10	32.99	32.89	188427.
15	220.92	150.00	95.79	2.52	38.42	32.89	32205.
16	227.97	155.59	94.75	11.58	38.42	32.89	147063.
17	240.25	166.42	91.87	12.98	43.85	32.89	159796.
18	252.61	179.48	86.80	11.74	49.28	32.89	136590.
19	263.68	193.64	79.80	10.40	54.71	32.89	111198.
20	273.36	208.80	70.90	8.96	60.14	32.89	85158.
21	281.57	224.79	60.21	7.45	65.56	32.89	60075.
22	285.75	234.31	53.40	.91	70.99	32.89	6506.
23	287.40	239.11	48.89	2.40	70.99	.00	15722.
24	289.88	246.30	41.70	2.55	70.99	.00	14264.
25	293.27	258.76	29.24	4.23	76.42	.00	16559.
26	296.13	272.75	15.25	1.50	81.85	.00	3071.
27	297.41	281.66	6.34	1.05	81.85	.00	891.
28	297.99	286.66	1.34	.13	87.28	.00	23.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	27.1161	8.6884	9.9575
3	27.6873	-----	8.6884
3	27.4017	8.7158	-----
4	27.6749	8.7421	8.7158
5	27.6689	8.7415	8.7421

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	9830.7	111168.0	45.00	0.	0.	0.	.00
2	10862.8	111168.0	45.00	0.	0.	0.	.00

3	8880.8	111168.0	45.00	0.	0.	0.	.00
4	7047.3	111168.0	45.00	0.	0.	0.	.00
5	7307.0	111168.0	45.00	0.	0.	0.	.00
6	3138.8	14112.0	35.00	0.	0.	0.	.00
7	3900.5	14112.0	35.00	0.	0.	0.	.00
8	5413.0	14112.0	35.00	0.	0.	0.	.00
9	7439.5	14112.0	35.00	0.	0.	0.	.00
10	8813.0	14112.0	35.00	0.	0.	0.	.00
11	8796.6	14112.0	35.00	0.	0.	0.	.00
12	8982.2	14112.0	35.00	0.	0.	0.	.00
13	8965.1	14112.0	35.00	0.	0.	0.	.00
14	8753.8	14112.0	35.00	0.	0.	0.	.00
15	8262.8	14112.0	35.00	0.	0.	0.	.00
16	8440.5	1515.0	42.00	0.	0.	0.	.00
17	7608.5	1515.0	42.00	0.	0.	0.	.00
18	6624.4	1515.0	42.00	0.	0.	0.	.00
19	5537.6	1515.0	42.00	0.	0.	0.	.00
20	4386.2	1515.0	42.00	0.	0.	0.	.00
21	3215.5	1515.0	42.00	0.	0.	0.	.00
22	2341.8	1515.0	42.00	0.	0.	0.	.00
23	2131.5	1515.0	42.00	0.	0.	0.	.00
24	1796.1	1515.0	42.00	0.	0.	0.	.00
25	888.4	1515.0	42.00	0.	0.	0.	.00
26	159.3	1515.0	42.00	0.	0.	0.	.00
27	-56.6	1515.0	42.00	0.	0.	0.	.00
28	-238.6	1515.0	42.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	91.85	9830.7	942.8	.0	13841.8
2	100.81	10862.8	1889.9	.0	13959.9
3	110.13	8880.8	1884.0	.0	13733.1
4	124.66	7047.3	1785.9	.0	13523.4
5	131.69	7307.0	2057.0	.0	13553.1
6	133.99	3138.8	2616.3	.0	1865.8
7	135.92	3900.5	3422.7	.0	1926.8
8	139.82	5413.0	5516.0	.0	2047.9
9	146.35	7439.5	7784.8	.0	2210.3
10	152.39	8813.0	9322.7	.0	2320.3
11	163.31	8796.6	10029.0	.0	2319.0
12	180.27	8982.2	11028.3	.0	2333.8
13	196.58	8965.1	11848.0	.0	2332.5
14	212.11	8753.8	12480.8	.0	2315.5
15	220.92	8262.8	12780.2	.0	2276.2
16	227.97	8440.5	12697.1	.0	1042.7
17	240.25	7608.5	12310.2	.0	957.0
18	252.61	6624.4	11631.7	.0	855.6
19	263.68	5537.6	10692.6	.0	743.7
20	273.36	4386.2	9501.2	.0	625.1
21	281.57	3215.5	8068.2	.0	504.5
22	285.75	2341.8	7155.3	.0	414.5
23	287.40	2131.5	6551.0	.0	392.9
24	289.88	1796.1	5587.6	.0	358.3

25	293.27	888.4	3918.8	.0	264.8
26	296.13	159.3	2043.2	.0	189.7
27	297.41	-56.6	849.4	.0	167.5
28	297.99	-238.6	179.4	.0	148.7

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	100.50	27.67	285925.	5.27	22.52	.234
2	101.13	27.67	296436.	5.46	22.57	.242
3	119.13	27.67	571541.	9.84	22.44	.439
4	130.20	27.67	729998.	11.85	21.31	.556
5	133.19	27.67	772686.	12.41	30.74	.404
6	134.80	27.67	775166.	13.04	35.83	.364
7	137.04	27.67	778417.	13.91	43.52	.320
8	142.60	27.67	782076.	15.55	62.10	.250
9	150.10	27.67	783617.	17.72	82.00	.216
10	154.69	27.67	783152.	19.02	84.05	.226
11	171.93	27.67	763236.	22.57	90.03	.251
12	188.60	27.67	723856.	24.80	94.02	.264
13	204.56	27.67	666625.	25.83	96.01	.269
14	219.66	27.67	594327.	25.74	95.97	.268
15	222.18	27.67	579610.	25.49	95.60	.267
16	233.76	27.67	494067.	25.41	93.91	.271
17	246.74	27.67	388336.	24.40	89.83	.272
18	258.48	27.67	286847.	22.58	83.78	.270
19	268.88	27.67	194928.	20.01	75.81	.264
20	277.84	27.67	117214.	16.72	66.00	.253
21	285.29	27.67	57208.	12.72	54.42	.234
22	286.20	27.67	50140.	11.93	52.37	.228
23	288.60	27.67	33193.	9.94	45.40	.219
24	291.15	27.67	18068.	8.34	37.99	.219
25	295.38	27.67	470.	-21.53	20.50	-1.050
26	296.88	27.67	-1339.	5.82	10.00	.582
27	297.93	27.67	-743.	1.31	2.68	.488
28	298.06	.00	-2.	-3.57	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 6208.60 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 3259.35 (psf)

Total Length of failure surface = 308.68 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

```
                    FACTOR OF SAFETY =   8.742

     Total shear strength available
     along specified failure surface =  879.48E+04   lb

*****************************************************************
  For the specified surface, the analysis computed the following:

     Negative (tensile) Normal Effective Force =  1 slices
     Negative (tensile) Interslice Force       =  2 slices
     Unreasonable Location of Interslice Force =  1 slices

  In view of these errors, the computed FOS may be UNREASONABLE!
*****************************************************************
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STATIC ANALYSIS OF BACKFILLED SLOPE, ROTATIONAL SURFACE WITH GEOSYNTHETIC DRAIN

(XSTABL Output File: 30012R4S.opt)

XSTABL File: 30012R4S 3-10-** 17:01

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*****************************************
*              X S T A B L              *
*                                       *
*       Slope Stability Analysis        *
*              using the                *
*           Method of Slices            *
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Problem Description : Andalex/West_Ridge/March_03

SEGMENT BOUNDARY COORDINATES

10 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	105.2	37.0	105.2	1
2	37.0	105.2	51.0	115.0	1
3	51.0	115.0	83.2	115.0	1
4	83.2	115.0	100.5	136.0	2
5	100.5	136.0	130.2	136.0	2
6	130.2	136.0	134.8	151.0	2
7	134.8	151.0	142.6	178.6	4
8	142.6	178.6	150.1	200.0	5
9	150.1	200.0	286.2	288.0	5
10	286.2	288.0	298.4	288.0	5

4 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	142.6	178.6	288.6	278.0	5
2	288.6	278.0	298.4	278.0	5
3	134.8	151.0	298.4	151.0	2
4	83.2	115.0	298.4	115.0	1

ISOTROPIC Soil Parameters

5 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	155.0	155.0	111168.0	45.00	.000	.0	0
2	78.6	78.6	14112.0	35.00	.000	.0	0
3	138.0	138.0	1877.0	54.00	.000	.0	0
4	155.5	155.5	111168.0	45.00	.000	.0	0
5	134.0	134.0	1515.0	42.00	.000	.0	0

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface is CIRCULAR, with a radius of 190.04 feet

Center at x = 108.74 ; y = 303.32 ; Seg. Length = 18.00 feet

The CIRCULAR failure surface was estimated by
the following 19 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	83.20	115.00
2	101.13	113.43
3	119.13	113.56
4	137.04	115.39
5	154.69	118.91
6	171.93	124.09
7	188.60	130.87
8	204.56	139.20
9	219.66	149.00
10	233.76	160.19
11	246.74	172.66
12	258.48	186.30
13	268.88	200.99
14	277.84	216.60
15	285.29	232.99
16	291.15	250.01
17	295.38	267.50
18	297.93	285.32
19	298.06	288.00

****

SELECTED METHOD OF ANALYSIS: Spencer (1973)

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SUMMARY OF INDIVIDUAL SLICE INFORMATION

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Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	91.85	114.24	11.26	17.30	-5.01	50.52	16311.
2	100.81	113.46	22.54	.63	-5.01	.00	1190.
3	110.13	113.49	22.51	18.00	.42	.00	33911.
4	124.66	114.13	21.87	11.07	5.85	.00	19771.
5	131.69	114.85	26.02	2.99	5.85	72.95	6142.
6	133.99	115.08	33.29	1.61	5.85	72.95	4222.
7	135.92	115.28	39.68	2.24	5.85	74.22	7652.
8	139.82	115.95	52.81	5.56	11.28	74.22	30693.
9	146.35	117.25	72.05	7.50	11.28	70.69	58386.
10	152.39	118.46	83.03	4.59	11.28	32.89	42774.
11	163.31	121.50	87.04	17.24	16.71	32.89	172903.
12	180.27	127.48	92.02	16.67	22.13	32.89	183879.
13	196.58	135.04	95.02	15.96	27.56	32.89	189058.
14	212.11	144.10	95.99	15.10	32.99	32.89	188427.
15	220.92	150.00	95.79	2.52	38.42	32.89	32205.
16	227.97	155.59	94.75	11.58	38.42	32.89	147063.
17	240.25	166.42	91.87	12.98	43.85	32.89	159796.
18	252.61	179.48	86.80	11.74	49.28	32.89	136590.
19	263.68	193.64	79.80	10.40	54.71	32.89	111198.
20	273.36	208.80	70.90	8.96	60.14	32.89	85158.
21	281.57	224.79	60.21	7.45	65.56	32.89	60075.
22	285.75	234.31	53.40	.91	70.99	32.89	6506.
23	287.40	239.11	48.89	2.40	70.99	.00	15722.
24	289.88	246.30	41.70	2.55	70.99	.00	14264.
25	293.27	258.76	29.24	4.23	76.42	.00	16559.
26	296.13	272.75	15.25	1.50	81.85	.00	3071.
27	297.41	281.66	6.34	1.05	81.85	.00	891.
28	297.99	286.66	1.34	.13	87.28	.00	23.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	24.9298	9.3275	10.9909
3	25.6287	9.4009	9.3275
4	25.5933	-----	9.4009
4	25.6110	9.3990	-----
5	25.5942	9.3972	9.3990
6	25.5946	9.3973	9.3972

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	8517.4	111168.0	45.00	0.	0.	0.	.00
2	9572.4	111168.0	45.00	0.	0.	0.	.00
3	7829.5	111168.0	45.00	0.	0.	0.	.00
4	6185.1	111168.0	45.00	0.	0.	0.	.00
5	6453.8	111168.0	45.00	0.	0.	0.	.00
6	3116.3	14112.0	35.00	0.	0.	0.	.00
7	3906.1	14112.0	35.00	0.	0.	0.	.00
8	5523.4	14112.0	35.00	0.	0.	0.	.00
9	7634.6	14112.0	35.00	0.	0.	0.	.00

10	9065.5	14112.0	35.00	0.	0.	0.	.00
11	9109.4	14112.0	35.00	0.	0.	0.	.00
12	9362.9	14112.0	35.00	0.	0.	0.	.00
13	9402.5	14112.0	35.00	0.	0.	0.	.00
14	9235.9	14112.0	35.00	0.	0.	0.	.00
15	8770.7	14112.0	35.00	0.	0.	0.	.00
16	8968.8	1515.0	42.00	0.	0.	0.	.00
17	8120.9	1515.0	42.00	0.	0.	0.	.00
18	7103.9	1515.0	42.00	0.	0.	0.	.00
19	5968.9	1515.0	42.00	0.	0.	0.	.00
20	4755.3	1515.0	42.00	0.	0.	0.	.00
21	3510.5	1515.0	42.00	0.	0.	0.	.00
22	2579.0	1515.0	42.00	0.	0.	0.	.00
23	2348.6	1515.0	42.00	0.	0.	0.	.00
24	1981.3	1515.0	42.00	0.	0.	0.	.00
25	998.3	1515.0	42.00	0.	0.	0.	.00
26	200.2	1515.0	42.00	0.	0.	0.	.00
27	-40.1	1515.0	42.00	0.	0.	0.	.00
28	-240.4	1515.0	42.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	91.85	8517.4	942.8	.0	12736.2
2	100.81	9572.4	1889.9	.0	12848.5
3	110.13	7829.5	1884.0	.0	12663.0
4	124.66	6185.1	1785.9	.0	12488.0
5	131.69	6453.8	2057.0	.0	12516.6
6	133.99	3116.3	2616.3	.0	1733.9
7	135.92	3906.1	3422.7	.0	1792.8
8	139.82	5523.4	5516.0	.0	1913.3
9	146.35	7634.6	7784.8	.0	2070.6
10	152.39	9065.5	9322.7	.0	2177.2
11	163.31	9109.4	10029.0	.0	2180.5
12	180.27	9362.9	11028.3	.0	2199.4
13	196.58	9402.5	11848.0	.0	2202.3
14	212.11	9235.9	12480.8	.0	2189.9
15	220.92	8770.7	12780.2	.0	2155.2
16	227.97	8968.8	12697.1	.0	1020.6
17	240.25	8120.9	12310.2	.0	939.3
18	252.61	7103.9	11631.7	.0	841.9
19	263.68	5968.9	10692.6	.0	733.1
20	273.36	4755.3	9501.2	.0	616.9
21	281.57	3510.5	8068.2	.0	497.6
22	285.75	2579.0	7155.3	.0	408.3
23	287.40	2348.6	6551.0	.0	386.2
24	289.88	1981.3	5587.6	.0	351.1
25	293.27	998.3	3918.8	.0	256.9
26	296.13	200.2	2043.2	.0	180.4
27	297.41	-40.1	849.4	.0	157.4
28	297.99	-240.4	179.4	.0	138.2

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	100.50	25.59	258630.	4.90	22.52	.218
2	101.13	25.59	268189.	5.08	22.57	.225
3	119.13	25.59	519773.	9.06	22.44	.404
4	130.20	25.59	665288.	10.79	21.31	.506
5	133.19	25.59	704542.	11.28	30.74	.367
6	134.80	25.59	707074.	11.85	35.83	.331
7	137.04	25.59	710526.	12.63	43.52	.290
8	142.60	25.59	715536.	14.09	62.10	.227
9	150.10	25.59	720095.	16.09	82.00	.196
10	154.69	25.59	721975.	17.33	84.05	.206
11	171.93	25.59	711394.	20.70	90.03	.230
12	188.60	25.59	681645.	22.83	94.02	.243
13	204.56	25.59	633776.	23.84	96.01	.248
14	219.66	25.59	570060.	23.79	95.97	.248
15	222.18	25.59	556644.	23.57	95.60	.247
16	233.76	25.59	478389.	23.49	93.91	.250
17	246.74	25.59	379624.	22.53	89.83	.251
18	258.48	25.59	283130.	20.83	83.78	.249
19	268.88	25.59	194349.	18.41	75.81	.243
20	277.84	25.59	118173.	15.32	66.00	.232
21	285.29	25.59	58493.	11.58	54.42	.213
22	286.20	25.59	51356.	10.83	52.37	.207
23	288.60	25.59	34239.	8.98	45.40	.198
24	291.15	25.59	18951.	7.54	37.99	.198
25	295.38	25.59	787.	-12.58	20.50	-.614
26	296.88	25.59	-1242.	6.19	10.00	.619
27	297.93	25.59	-733.	1.31	2.68	.487
28	298.06	.00	0.	1.38	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 6308.58 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 3037.28 (psf)

Total Length of failure surface = 308.68 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 9.397

Total shear strength available along specified failure surface = 881.04E+04 lb

****

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   For the specified surface, the analysis computed the following:

      Negative (tensile) Normal Effective Force =  1 slices
      Negative (tensile) Interslice Force       =  2 slices
      Unreasonable Location of Interslice Force =  1 slices

   In view of these errors, the computed FOS may be UNREASONABLE!
*****************************************************************
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Pseudostatic Analysis of Backfilled Slope, Rotational Surface with Geosynthetic Drain

(XSTABL Output File: 3012R4SP.opt)

XSTABL File: 3012R4SP   3-10-**   20:11

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****************************************
*               X S T A B L            *
*                                      *
*       Slope Stability Analysis       *
*             using the                *
*          Method of Slices            *
*                                      *
*        Copyright (C) 1992 á 98       *
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*                                      *
*  Ver. 5.202                96 á 1647 *
****************************************
```

Problem Description : Andalex/West_Ridge/March_03

SEGMENT BOUNDARY COORDINATES

----

6 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	105.2	37.0	105.2	1
2	37.0	105.2	51.0	115.0	1
3	51.0	115.0	56.1	119.4	6
4	56.1	119.4	150.1	200.0	3
5	150.1	200.0	286.2	288.0	5
6	286.2	288.0	298.4	288.0	5

10 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	142.6	178.6	150.1	200.0	7
2	134.8	151.0	142.6	178.6	7
3	142.6	178.6	288.6	278.0	4
4	288.6	278.0	298.4	278.0	4
5	56.1	119.4	86.4	119.4	7
6	86.4	119.4	100.5	136.0	7
7	100.5	136.0	130.2	136.0	7
8	130.2	136.0	134.8	151.0	7
9	134.8	151.0	298.4	151.0	2
10	51.0	115.0	298.4	115.0	1

ISOTROPIC Soil Parameters
----

7 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	155.0	155.0	111168.0	45.00	.000	.0	0
2	78.6	78.6	14112.0	35.00	.000	.0	0
3	138.0	138.0	1877.0	54.00	.000	.0	0
4	155.5	155.5	111168.0	45.00	.000	.0	0
5	134.0	134.0	1515.0	42.00	.000	.0	0
6	120.0	120.0	100.0	40.00	.000	.0	0
7	100.0	100.0	.0	18.00	.000	.0	0

A horizontal earthquake loading coefficient
of .070 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface is CIRCULAR, with a radius of 108.08 feet

Center at x = 44.90 ; y = 224.52 ; Seg. Length = 9.00 feet

The CIRCULAR failure surface was estimated by
the following 17 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	53.02	116.74
2	61.96	117.79
3	70.78	119.58
4	79.42	122.10
5	87.82	125.33
6	95.93	129.24
7	103.68	133.82
8	111.02	139.02
9	117.90	144.82
10	124.28	151.17
11	130.11	158.03
12	135.34	165.35
13	139.95	173.08
14	143.90	181.16
15	147.17	189.55
16	149.72	198.18
17	150.10	200.00

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**************************************************
SELECTED METHOD OF ANALYSIS:  Spencer (1973)
**************************************************
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***************************************
SUMMARY OF INDIVIDUAL SLICE INFORMATION
***************************************
```

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	54.56	116.92	1.15	3.08	6.69	40.79	424.
2	59.03	117.45	4.46	5.86	6.69	40.61	3174.
3	65.92	118.60	9.23	7.93	11.47	40.61	9850.
4	70.33	119.49	12.11	.89	11.47	40.61	1493.
5	75.10	120.84	14.85	8.64	16.24	40.61	17709.
6	83.62	123.71	19.29	8.40	21.01	40.61	22360.
7	90.88	126.80	22.42	6.12	25.78	40.61	18949.
8	94.94	128.76	23.94	1.98	25.78	40.61	6488.
9	98.21	130.59	24.92	4.57	30.56	40.61	15259.
10	102.09	132.88	25.95	3.18	30.56	40.61	10997.
11	105.22	134.91	26.61	3.08	35.33	40.61	11188.
12	108.89	137.51	27.15	4.26	35.33	40.61	15965.
13	114.46	141.92	27.52	6.88	40.10	40.61	26146.
14	121.09	147.99	27.13	6.38	44.87	40.61	23883.
15	127.19	154.60	25.76	5.83	49.65	40.61	20719.
16	132.73	161.69	23.42	5.24	54.42	40.61	16923.
17	137.65	169.21	20.11	4.61	59.19	40.61	12795.
18	141.24	175.71	16.70	2.57	63.96	40.61	5927.
19	142.56	178.42	15.12	.07	63.96	40.61	152.
20	142.64	178.57	15.03	.08	63.96	40.61	165.
21	143.29	179.91	14.25	1.22	63.96	40.61	2379.
22	145.54	185.36	10.73	3.26	68.74	40.61	4633.
23	148.45	193.86	4.72	2.55	73.51	40.61	1526.
24	149.91	199.09	.75	.38	78.28	40.61	34.

```
--------------------------------
ITERATIONS FOR SPENCER'S METHOD
--------------------------------
```

Iter #	Theta	FOS_force	FOS_moment
2	43.3348	2.5112	2.4879
3	42.7785	-----	2.5112
3	43.0567	2.5087	-----
4	42.8362	2.5068	2.5087
5	42.8590	2.5070	2.5068

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	192.4	100.0	40.00	0.	0.	0.	.00
2	504.7	.0	18.00	0.	0.	0.	.00
3	1061.8	.0	18.00	0.	0.	0.	.00
4	2665.1	1877.0	54.00	0.	0.	0.	.00

5	2599.0	1877.0	54.00	0.	0.	0.	.00
6	2737.4	1877.0	54.00	0.	0.	0.	.00
7	2679.4	1877.0	54.00	0.	0.	0.	.00
8	2203.6	.0	18.00	0.	0.	0.	.00
9	2073.7	.0	18.00	0.	0.	0.	.00
10	2152.9	.0	18.00	0.	0.	0.	.00
11	2083.4	.0	18.00	0.	0.	0.	.00
12	2385.7	1877.0	54.00	0.	0.	0.	.00
13	2084.7	1877.0	54.00	0.	0.	0.	.00
14	1759.6	1877.0	54.00	0.	0.	0.	.00
15	1407.9	1877.0	54.00	0.	0.	0.	.00
16	1045.0	1877.0	54.00	0.	0.	0.	.00
17	685.7	1877.0	54.00	0.	0.	0.	.00
18	374.6	1877.0	54.00	0.	0.	0.	.00
19	640.3	.0	18.00	0.	0.	0.	.00
20	-14252.1	111168.0	45.00	0.	0.	0.	.00
21	596.4	.0	18.00	0.	0.	0.	.00
22	368.9	.0	18.00	0.	0.	0.	.00
23	125.4	.0	18.00	0.	0.	0.	.00
24	14.4	.0	18.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	54.56	192.4	137.7	.0	104.3
2	59.03	504.7	541.8	.0	65.4
3	65.92	1061.8	1242.6	.0	137.6
4	70.33	2665.1	1671.6	.0	2211.9
5	75.10	2599.0	2049.5	.0	2175.6
6	83.62	2737.4	2661.5	.0	2251.6
7	90.88	2679.4	3094.1	.0	2219.8
8	94.94	2203.6	3277.3	.0	285.6
9	98.21	2073.7	3335.6	.0	268.8
10	102.09	2152.9	3463.0	.0	279.0
11	105.22	2083.4	3630.3	.0	270.0
12	108.89	2385.7	3747.1	.0	2058.5
13	114.46	2084.7	3798.1	.0	1893.3
14	121.09	1759.6	3744.5	.0	1714.8
15	127.19	1407.9	3555.3	.0	1521.7
16	132.73	1045.0	3231.6	.0	1322.4
17	137.65	685.7	2775.7	.0	1125.2
18	141.24	374.6	2303.9	.0	954.4
19	142.56	640.3	2084.7	.0	83.0
20	142.64	-14252.1	2071.9	.0	38658.3
21	143.29	596.4	1941.8	.0	77.3
22	145.54	368.9	1419.3	.0	47.8
23	148.45	125.4	597.2	.0	16.3
24	149.91	14.4	89.1	.0	1.9

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	56.10	42.86	303.	1.17	2.30	.511
2	61.96	42.86	49.	9.43	6.63	1.422
3	69.89	42.86	-1733.	5.09	11.82	.431
4	70.78	42.86	161.	-63.31	12.41	-5.104
5	79.42	42.86	15192.	1.28	17.30	.074
6	87.82	42.86	26812.	3.54	21.27	.167
7	93.95	42.86	32734.	4.76	23.57	.202
8	95.93	42.86	30011.	5.87	24.31	.241
9	100.50	42.86	22591.	8.77	25.53	.344
10	103.68	42.86	17244.	11.92	26.38	.452
11	106.76	42.86	11102.	18.09	26.84	.674
12	111.02	42.86	11714.	16.28	27.47	.593
13	117.90	42.86	10510.	15.51	27.57	.562
14	124.28	42.86	7906.	16.20	26.69	.607
15	130.11	42.86	4852.	19.23	24.83	.775
16	135.34	42.86	2248.	29.20	22.00	1.327
17	139.95	42.86	871.	55.02	18.23	3.019
18	142.53	42.86	963.	42.10	15.17	2.776
19	142.60	42.86	826.	48.85	15.08	3.240
20	142.68	42.86	8191.	4.87	14.98	.325
21	143.90	42.86	6053.	4.71	13.53	.348
22	147.17	42.86	1602.	3.45	7.94	.434
23	149.72	42.86	37.	.77	1.50	.515
24	150.10	.00	-1.	-2.05	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 1415.10 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 1134.43 (psf)

Total Length of failure surface = 136.86 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 2.507

Total shear strength available
along specified failure surface = 389.23E+03 lb

****

For the specified surface, the analysis computed the following:

Negative (tensile) Normal Effective Force = 1 slices
Negative (tensile) Interslice Force = 1 slices
Unreasonable Location of Interslice Force = 6 slices

In view of these errors, the computed FOS may be UNREASONABLE!

STATIC ANALYSIS OF BACKFILLED SLOPE,

ROTATIONAL SURFACE,

NO GEOSYNTHETIC DRAIN

(XSTABL Output File: 3019R4S.opt)

XSTABL File: 3019R4S   3-10-**   19:27

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******************************************
*              X S T A B L               *
*                                        *
*        Slope Stability Analysis        *
*               using the                *
*            Method of Slices            *
*                                        *
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Problem Description : Andalex/West_Ridge/March_03

SEGMENT BOUNDARY COORDINATES
----

6 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	105.2	37.0	105.2	1
2	37.0	105.2	51.0	115.0	1
3	51.0	115.0	56.1	119.4	6
4	56.1	119.4	150.1	200.0	3
5	150.1	200.0	286.2	288.0	5
6	286.2	288.0	298.4	288.0	5

10 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	142.6	178.6	150.1	200.0	5
2	134.8	151.0	142.6	178.6	4
3	142.6	178.6	288.6	278.0	4
4	288.6	278.0	298.4	278.0	4
5	56.1	119.4	86.4	119.4	6
6	86.4	119.4	100.5	136.0	2
7	100.5	136.0	130.2	136.0	2
8	130.2	136.0	134.8	151.0	2
9	134.8	151.0	298.4	151.0	2
10	51.0	115.0	298.4	115.0	1

ISOTROPIC Soil Parameters
----

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Constant (psf)	Water Surface No.
1	155.0	155.0	111168.0	45.00	.000	.0	0
2	78.6	78.6	14112.0	35.00	.000	.0	0
3	138.0	138.0	1877.0	54.00	.000	.0	0
4	155.5	155.5	111168.0	45.00	.000	.0	0
5	134.0	134.0	1515.0	42.00	.000	.0	0
6	120.0	120.0	100.0	40.00	.000	.0	0

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface is CIRCULAR, with a radius of 138.98 feet

Center at x = 20.71 ; y = 250.64 ; Seg. Length = 9.00 feet

The CIRCULAR failure surface was estimated by
the following 17 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	51.00	115.00
2	59.72	117.24
3	68.27	120.05
4	76.62	123.40
5	84.74	127.29
6	92.59	131.69
7	100.14	136.59
8	107.35	141.97
9	114.20	147.81
10	120.66	154.07
11	126.70	160.74
12	132.30	167.79
13	137.43	175.19
14	142.07	182.90
15	146.20	190.90
16	149.80	199.15
17	150.11	200.01

****

SELECTED METHOD OF ANALYSIS: Spencer (1973)

****

****

SUMMARY OF INDIVIDUAL SLICE INFORMATION

****

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	53.55	115.66	1.54	5.10	14.44	40.79	944.
2	57.91	116.78	4.17	3.62	14.44	40.61	1910.
3	63.00	118.32	7.00	6.57	18.15	40.61	6217.
4	67.28	119.72	9.26	1.98	18.15	40.61	2530.
5	72.44	121.73	11.69	8.35	21.87	40.61	13473.
6	80.68	125.34	15.13	8.12	25.58	40.61	16952.
7	88.66	129.49	17.83	7.85	29.29	40.61	19318.
8	96.36	134.14	19.78	7.55	33.00	40.61	20606.
9	103.74	139.28	20.97	7.22	36.71	40.61	20880.
10	110.78	144.89	21.39	6.85	40.42	40.61	20229.
11	117.43	150.94	21.05	6.46	44.13	40.61	18765.
12	123.68	157.41	19.94	6.04	47.84	40.61	16622.
13	129.50	164.27	18.07	5.60	51.55	40.61	13954.
14	134.86	171.49	15.44	5.13	55.26	40.61	10929.
15	139.75	179.05	12.08	4.64	58.98	40.61	7731.
16	144.13	186.90	7.98	4.13	62.69	40.61	4549.
17	148.00	195.02	3.18	3.60	66.40	40.61	1579.
18	149.82	199.21	.55	.04	70.11	40.61	3.
19	149.97	199.62	.27	.26	70.11	40.61	10.
20	150.11	199.99	.01	.01	70.11	40.61	0.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	25.7819	3.6359	3.6621
3	22.7531	3.6318	3.6359
4	21.9858	3.6309	3.6318

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	176.8	100.0	40.00	0.	0.	0.	.00
2	497.5	100.0	40.00	0.	0.	0.	.00
3	850.4	100.0	40.00	0.	0.	0.	.00
4	1193.4	1877.0	54.00	0.	0.	0.	.00
5	1390.3	1877.0	54.00	0.	0.	0.	.00
6	1677.6	1877.0	54.00	0.	0.	0.	.00
7	1850.5	1877.0	54.00	0.	0.	0.	.00
8	1920.6	1877.0	54.00	0.	0.	0.	.00
9	1899.3	1877.0	54.00	0.	0.	0.	.00
10	1797.5	1877.0	54.00	0.	0.	0.	.00
11	1626.1	1877.0	54.00	0.	0.	0.	.00
12	1396.1	1877.0	54.00	0.	0.	0.	.00
13	1119.0	1877.0	54.00	0.	0.	0.	.00
14	806.9	1877.0	54.00	0.	0.	0.	.00
15	472.8	1877.0	54.00	0.	0.	0.	.00
16	130.9	1877.0	54.00	0.	0.	0.	.00
17	-203.2	1877.0	54.00	0.	0.	0.	.00
18	-379.8	1877.0	54.00	0.	0.	0.	.00
19	-350.9	1515.0	42.00	0.	0.	0.	.00

20	-394.7	1877.0	54.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	53.55	176.8	185.2	.0	68.4
2	57.91	497.5	528.4	.0	142.5
3	63.00	850.4	946.0	.0	224.1
4	67.28	1193.4	1277.8	.0	969.3
5	72.44	1390.3	1613.1	.0	1044.0
6	80.68	1677.6	2088.2	.0	1152.9
7	88.66	1850.5	2461.0	.0	1218.4
8	96.36	1920.6	2730.0	.0	1245.0
9	103.74	1899.3	2894.0	.0	1236.9
10	110.78	1797.5	2952.4	.0	1198.3
11	117.43	1626.1	2904.9	.0	1133.4
12	123.68	1396.1	2751.7	.0	1046.2
13	129.50	1119.0	2493.5	.0	941.1
14	134.86	806.9	2131.2	.0	822.8
15	139.75	472.8	1666.6	.0	696.2
16	144.13	130.9	1101.4	.0	566.6
17	148.00	-203.2	438.2	.0	439.9
18	149.82	-379.8	76.6	.0	373.0
19	149.97	-350.9	37.0	.0	330.2
20	150.11	-394.7	1.8	.0	367.3

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	56.10	21.99	126.	.37	3.09	.121
2	59.72	21.99	182.	.71	5.26	.134
3	66.29	21.99	-207.	-.59	8.74	-.067
4	68.27	21.99	1027.	.18	9.78	.018
5	76.62	21.99	5406.	.05	13.59	.003
6	84.74	21.99	8469.	-.47	16.67	-.028
7	92.59	21.99	9997.	-1.54	19.00	-.081
8	100.14	21.99	9980.	-3.40	20.57	-.165
9	107.35	21.99	8585.	-6.61	21.37	-.309
10	114.20	21.99	6128.	-12.94	21.41	-.604
11	120.66	21.99	3034.	-31.55	20.69	-1.525
12	126.70	21.99	-196.	605.15	19.19	31.529
13	132.30	21.99	-3022.	31.77	16.94	1.875
14	137.43	21.99	-4908.	15.21	13.94	1.090
15	142.07	21.99	-5357.	8.33	10.21	.816
16	146.20	21.99	-3963.	3.82	5.75	.663
17	149.80	21.99	-445.	.37	.60	.612
18	149.84	21.99	-379.	.32	.51	.620
19	150.10	21.99	-18.	.01	.02	.567

```
   20     150.11        .00           -1.       .49        .00      .000


  ------------------------------------------------------------
   AVERAGE VALUES ALONG FAILURE SURFACE
  ------------------------------------------------------------

         Total Normal Stress =   1131.49  (psf)
         Pore Water Pressure =       .00  (psf)
         Shear Stress        =    878.82  (psf)

         Total Length of failure surface =  135.92 feet

  ------------------------------------------------------------


       For the single specified surface and the assumed angle
       of the interslice forces, the SPENCER'S (1973)
       procedure gives a

                  FACTOR OF SAFETY =   3.631

       Total shear strength available
       along specified failure surface =  433.70E+03   lb

*****************************************************************
   For the specified surface, the analysis computed the following:

       Negative (tensile) Normal Effective Force =  3 slices
       Negative (tensile) Interslice Force       =  8 slices
       Unreasonable Location of Interslice Force = 10 slices

   In view of these errors, the computed FOS may be UNREASONABLE!
*****************************************************************
```

PSEUDOSTATIC ANALYSIS OF BACKFILLED SLOPE,
ROTATIONAL SURFACE,
NO GEOSYNTHETIC DRAIN

(XSTABL Output File: 3019R4SP.opt)

XSTABL File: 3019R4SP 3-10-** 19:29

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****************************************
*                X S T A B L           *
*                                      *
*      Slope Stability Analysis        *
*             using the                *
*         Method of Slices             *
*                                      *
*       Copyright (C) 1992 á 98        *
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*                                      *
*  Ver. 5.202                96 á 1647 *
****************************************
```

Problem Description : Andalex/West_Ridge/March_03

SEGMENT BOUNDARY COORDINATES

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6 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	105.2	37.0	105.2	1
2	37.0	105.2	51.0	115.0	1
3	51.0	115.0	56.1	119.4	6
4	56.1	119.4	150.1	200.0	3
5	150.1	200.0	286.2	288.0	5
6	286.2	288.0	298.4	288.0	5

10 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	142.6	178.6	150.1	200.0	5
2	134.8	151.0	142.6	178.6	4
3	142.6	178.6	288.6	278.0	4
4	288.6	278.0	298.4	278.0	4
5	56.1	119.4	86.4	119.4	6
6	86.4	119.4	100.5	136.0	2
7	100.5	136.0	130.2	136.0	2
8	130.2	136.0	134.8	151.0	2
9	134.8	151.0	298.4	151.0	2
10	51.0	115.0	298.4	115.0	1

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	41.0827	1.2996	1.2883
3	41.0882	1.2997	1.2996

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	2292.4	.0	18.00	0.	0.	0.	.00
2	1556.9	.0	18.00	0.	0.	0.	.00
3	6035.9	.0	18.00	0.	0.	0.	.00
4	1286.8	.0	18.00	0.	0.	0.	.00
5	738.3	.0	18.00	0.	0.	0.	.00
6	259.3	.0	18.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	71.25	2292.4	1792.7	.0	573.1
2	93.45	1556.9	3274.1	.0	389.2
3	115.35	6035.9	4720.1	.0	1508.9
4	132.50	1286.8	5714.4	.0	321.7
5	138.70	738.3	3508.7	.0	184.6
6	146.35	259.3	1032.9	.0	64.8

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	86.40	41.09	23039.	13.21	25.98	.509
2	100.50	41.09	-3970.	-66.36	21.47	-3.091
3	130.20	41.09	55491.	16.77	46.94	.357
4	134.80	41.09	31844.	14.16	35.88	.395
5	142.60	41.09	6716.	7.43	14.97	.496
6	150.10	.00	-2.	-.01	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 2216.56 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 554.13 (psf)

Total Length of failure surface = 148.83 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 1.300

Total shear strength available
along specified failure surface = 107.19E+03 lb

****
For the specified surface, the analysis computed the following:

Negative (tensile) Normal Effective Force = 0 slices
Negative (tensile) Interslice Force = 1 slices
Unreasonable Location of Interslice Force = 1 slices

In view of these errors, the computed FOS may be UNREASONABLE!
****

Pseudostatic Analysis of Backfilled Slope, Plane Shear Surface with Geosynthetic Drain

(XSTABL Output File: 3024R4P.opt)

XSTABL File: 3024R4P   3-10-**   20:26

```
*****************************************
*              X S T A B L              *
*                                       *
*       Slope Stability Analysis        *
*             using the                 *
*          Method of Slices             *
*                                       *
*        Copyright (C) 1992 á 98        *
*   Interactive Software Designs, Inc.  *
*       Moscow, ID 83843, U.S.A.        *
*                                       *
*          All Rights Reserved          *
*                                       *
*  Ver. 5.202                96 á 1647  *
*****************************************
```

Problem Description : Andalex/West_Ridge/March_03

SEGMENT BOUNDARY COORDINATES
----

6 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	105.2	37.0	105.2	1
2	37.0	105.2	51.0	115.0	1
3	51.0	115.0	56.1	119.4	6
4	56.1	119.4	150.1	200.0	3
5	150.1	200.0	286.2	288.0	5
6	286.2	288.0	298.4	288.0	5

10 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	142.6	178.6	150.1	200.0	7
2	134.8	151.0	142.6	178.6	7
3	142.6	178.6	288.6	278.0	4
4	288.6	278.0	298.4	278.0	4
5	56.1	119.4	86.4	119.4	7
6	86.4	119.4	100.5	136.0	7
7	100.5	136.0	130.2	136.0	7
8	130.2	136.0	134.8	151.0	7
9	134.8	151.0	298.4	151.0	2
10	51.0	115.0	298.4	115.0	1

ISOTROPIC Soil Parameters

---

7 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	155.0	155.0	111168.0	45.00	.000	.0	0
2	78.6	78.6	14112.0	35.00	.000	.0	0
3	138.0	138.0	1877.0	54.00	.000	.0	0
4	155.5	155.5	111168.0	45.00	.000	.0	0
5	134.0	134.0	1515.0	42.00	.000	.0	0
6	120.0	120.0	100.0	40.00	.000	.0	0
7	100.0	100.0	.0	18.00	.000	.0	0

A horizontal earthquake loading coefficient
of .070 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface specified by
the following 7 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	56.10	119.40
2	86.40	119.40
3	100.50	136.00
4	130.20	136.00
5	134.80	151.00
6	142.60	178.60
7	150.10	200.00

****
SELECTED METHOD OF ANALYSIS: Spencer (1973)
****

****
SUMMARY OF INDIVIDUAL SLICE INFORMATION
****

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)

1	71.25	119.40	12.99	30.30	.00	40.61	54318.
2	93.45	127.70	23.73	14.10	49.66	40.61	46165.
3	115.35	136.00	34.20	29.70	.00	40.61	140187.
4	132.50	143.50	41.41	4.60	72.95	40.61	26286.
5	138.70	164.80	25.43	7.80	74.22	40.61	27368.
6	146.35	189.30	7.48	7.50	70.69	40.61	7747.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	49.1024	1.2135	1.0526
3	49.4219	1.2206	1.2135
4	49.4323	1.2209	1.2206

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	2388.6	.0	18.00	0.	0.	0.	.00
2	1264.5	.0	18.00	0.	0.	0.	.00
3	6289.3	.0	18.00	0.	0.	0.	.00
4	977.9	.0	18.00	0.	0.	0.	.00
5	559.0	.0	18.00	0.	0.	0.	.00
6	198.5	.0	18.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	71.25	2388.6	1792.7	.0	635.7
2	93.45	1264.5	3274.1	.0	336.5
3	115.35	6289.3	4720.1	.0	1673.8
4	132.50	977.9	5714.4	.0	260.3
5	138.70	559.0	3508.7	.0	148.8
6	146.35	198.5	1032.9	.0	52.8

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	86.40	49.43	23772.	16.10	25.98	.620
2	100.50	49.43	-6177.	-52.25	21.47	-2.434
3	130.20	49.43	55175.	16.57	46.94	.353
4	134.80	49.43	31632.	13.85	35.88	.386
5	142.60	49.43	6749.	6.78	14.97	.453
6	150.10	.00	-5.	.16	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

```
      Total Normal Stress =   2167.51  (psf)
      Pore Water Pressure =       .00  (psf)
      Shear Stress        =    576.86  (psf)

      Total Length of failure surface =  148.83 feet
```

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 1.221

Total shear strength available
along specified failure surface = 104.81E+03 lb

****

For the specified surface, the analysis computed the following:

```
   Negative (tensile) Normal Effective Force =  0 slices
   Negative (tensile) Interslice Force       =  1 slices
   Unreasonable Location of Interslice Force =  1 slices
```

In view of these errors, the computed FOS may be UNREASONABLE!

****

ISOTROPIC Soil Parameters
----

6 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	155.0	155.0	111168.0	45.00	.000	.0	0
2	78.6	78.6	14112.0	35.00	.000	.0	0
3	138.0	138.0	1877.0	54.00	.000	.0	0
4	155.5	155.5	111168.0	45.00	.000	.0	0
5	134.0	134.0	1515.0	42.00	.000	.0	0
6	120.0	120.0	100.0	40.00	.000	.0	0

A horizontal earthquake loading coefficient
of .070 has been assigned

A vertical earthquake loading coefficient
of .000 has been assigned

A SINGLE FAILURE SURFACE HAS BEEN SPECIFIED FOR ANALYSIS

Trial failure surface is CIRCULAR, with a radius of 138.98 feet

Center at x = 20.71 ; y = 250.64 ; Seg. Length = 9.00 feet

The CIRCULAR failure surface was estimated by
the following 17 coordinate points :

Point No.	x-surf (ft)	y-surf (ft)
1	51.00	115.00
2	59.72	117.24
3	68.27	120.05
4	76.62	123.40
5	84.74	127.29
6	92.59	131.69
7	100.14	136.59
8	107.35	141.97
9	114.20	147.81
10	120.66	154.07
11	126.70	160.74
12	132.30	167.79
13	137.43	175.19
14	142.07	182.90
15	146.20	190.90
16	149.80	199.15
17	150.11	200.01

****

SELECTED METHOD OF ANALYSIS: Spencer (1973)
****

****
SUMMARY OF INDIVIDUAL SLICE INFORMATION
****

Slice	x-base (ft)	y-base (ft)	height (ft)	width (ft)	alpha	beta	weight (lb)
1	53.55	115.66	1.54	5.10	14.44	40.79	944.
2	57.91	116.78	4.17	3.62	14.44	40.61	1910.
3	63.00	118.32	7.00	6.57	18.15	40.61	6217.
4	67.28	119.72	9.26	1.98	18.15	40.61	2530.
5	72.44	121.73	11.69	8.35	21.87	40.61	13473.
6	80.68	125.34	15.13	8.12	25.58	40.61	16952.
7	88.66	129.49	17.83	7.85	29.29	40.61	19318.
8	96.36	134.14	19.78	7.55	33.00	40.61	20606.
9	103.74	139.28	20.97	7.22	36.71	40.61	20880.
10	110.78	144.89	21.39	6.85	40.42	40.61	20229.
11	117.43	150.94	21.05	6.46	44.13	40.61	18765.
12	123.68	157.41	19.94	6.04	47.84	40.61	16622.
13	129.50	164.27	18.07	5.60	51.55	40.61	13954.
14	134.86	171.49	15.44	5.13	55.26	40.61	10929.
15	139.75	179.05	12.08	4.64	58.98	40.61	7731.
16	144.13	186.90	7.98	4.13	62.69	40.61	4549.
17	148.00	195.02	3.18	3.60	66.40	40.61	1579.
18	149.82	199.21	.55	.04	70.11	40.61	3.
19	149.97	199.62	.27	.26	70.11	40.61	10.
20	150.11	199.99	.01	.01	70.11	40.61	0.

ITERATIONS FOR SPENCER'S METHOD

Iter #	Theta	FOS_force	FOS_moment
2	40.7171	3.2700	3.2698

SLICE INFORMATION ... continued :

Slice	Sigma (psf)	c-value (psf)	phi	U-base (lb)	U-top (lb)	P-top (lb)	Delta
1	180.4	100.0	40.00	0.	0.	0.	.00
2	482.7	100.0	40.00	0.	0.	0.	.00
3	790.3	100.0	40.00	0.	0.	0.	.00
4	1424.1	1877.0	54.00	0.	0.	0.	.00
5	1544.7	1877.0	54.00	0.	0.	0.	.00
6	1743.8	1877.0	54.00	0.	0.	0.	.00
7	1831.7	1877.0	54.00	0.	0.	0.	.00
8	1827.8	1877.0	54.00	0.	0.	0.	.00
9	1748.3	1877.0	54.00	0.	0.	0.	.00
10	1607.5	1877.0	54.00	0.	0.	0.	.00
11	1417.9	1877.0	54.00	0.	0.	0.	.00
12	1191.3	1877.0	54.00	0.	0.	0.	.00
13	938.8	1877.0	54.00	0.	0.	0.	.00

14	671.3	1877.0	54.00	0.	0.	0.	.00
15	399.4	1877.0	54.00	0.	0.	0.	.00
16	133.9	1877.0	54.00	0.	0.	0.	.00
17	-114.2	1877.0	54.00	0.	0.	0.	.00
18	-244.1	1877.0	54.00	0.	0.	0.	.00
19	-217.0	1515.0	42.00	0.	0.	0.	.00
20	-257.1	1877.0	54.00	0.	0.	0.	.00

SPENCER'S (1973) - TOTAL Stresses at center of slice base

Slice #	Base x-coord (ft)	Normal Stress (psf)	Vertical Stress (psf)	Pore Water Pressure (psf)	Shear Stress (psf)
1	53.55	180.4	185.2	.0	76.9
2	57.91	482.7	528.4	.0	154.4
3	63.00	790.3	946.0	.0	233.4
4	67.28	1424.1	1277.8	.0	1173.4
5	72.44	1544.7	1613.1	.0	1224.2
6	80.68	1743.8	2088.2	.0	1308.0
7	88.66	1831.7	2461.0	.0	1345.0
8	96.36	1827.8	2730.0	.0	1343.4
9	103.74	1748.3	2894.0	.0	1309.9
10	110.78	1607.5	2952.4	.0	1250.6
11	117.43	1417.9	2904.9	.0	1170.8
12	123.68	1191.3	2751.7	.0	1075.4
13	129.50	938.8	2493.5	.0	969.2
14	134.86	671.3	2131.2	.0	856.6
15	139.75	399.4	1666.6	.0	742.1
16	144.13	133.9	1101.4	.0	630.4
17	148.00	-114.2	438.2	.0	525.9
18	149.82	-244.1	76.6	.0	471.3
19	149.97	-217.0	37.0	.0	403.5
20	150.11	-257.1	1.8	.0	465.8

SPENCER'S (1973) - Magnitude & Location of Interslice Forces

Slice #	Right x-coord (ft)	Force Angle (degrees)	Interslice Force (lb)	Force Height (ft)	Boundary Height (ft)	Height Ratio
1	56.10	40.72	117.	.96	3.09	.312
2	59.72	40.72	85.	-.56	5.26	-.106
3	66.29	40.72	-713.	4.48	8.74	.513
4	68.27	40.72	898.	-4.65	9.78	-.476
5	76.62	40.72	6314.	.38	13.59	.028
6	84.74	40.72	9818.	1.58	16.67	.095
7	92.59	40.72	11324.	2.16	19.00	.114
8	100.14	40.72	10979.	2.13	20.57	.104
9	107.35	40.72	9110.	1.26	21.37	.059
10	114.20	40.72	6171.	-1.30	21.41	-.061
11	120.66	40.72	2694.	-10.94	20.69	-.529
12	126.70	40.72	-757.	60.68	19.19	3.161
13	132.30	40.72	-3621.	14.60	16.94	.861

14	137.43	40.72	-5386.	8.77	13.94	.629
15	142.07	40.72	-5622.	5.53	10.21	.541
16	146.20	40.72	-4020.	2.82	5.75	.489
17	149.80	40.72	-422.	.29	.60	.491
18	149.84	40.72	-357.	.26	.51	.500
19	150.10	40.72	-17.	.01	.02	.436
20	150.11	.00	0.	-.08	.00	.000

AVERAGE VALUES ALONG FAILURE SURFACE

Total Normal Stress = 1070.23 (psf)
Pore Water Pressure = .00 (psf)
Shear Stress = 950.47 (psf)

Total Length of failure surface = 135.92 feet

For the single specified surface and the assumed angle of the interslice forces, the SPENCER'S (1973) procedure gives a

FACTOR OF SAFETY = 3.270

Total shear strength available
along specified failure surface = 422.43E+03 lb

****
For the specified surface, the analysis computed the following:

Negative (tensile) Normal Effective Force = 3 slices
Negative (tensile) Interslice Force = 8 slices
Unreasonable Location of Interslice Force = 5 slices

In view of these errors, the computed FOS may be UNREASONABLE!
****

APPENDIX C

SURFICIAL STABILITY ANALYSIS

BY TENSAR

Tensar® Surficial Slope Stability Solution Software

Project Name	Surficial Stability in CO		
Project Number	D03102	Date	3/11/03
Client	Agapito Associates, Inc.	Designer	JHL
Description		File	K:_d\D03102\surficial

4' topsoil

Input Data

Static Overall FoS	1.30	Seismic Overall FoS	N/A
FoS against Pullout	1.50	Seismic Acceleration Coef.	N/A
Slope Angle (deg.)	40.00	Vertical Saturation Depth (ft)	4.00
Soil Type	Sand, silt, or clay		
Unit Weight (pcf)	130.00	Friction Angle (deg.)	39.00
Surficial Cohesion (psf)	50.00	Surf. Cohesion Zone Width (ft)	4.00
Deep Cohesion (psf)	50.00		

	Primary Geogrid	Secondary Geogrid
Type	None	BX1100
Long Term Design Strength (lb/ft)	N/A	255
Coefficient of Interaction	N/A	0.90
Partial Factor of Durability	N/A	1.00
Vertical Spacing (ft)	N/A	1.50
Percent Coverage	N/A	
Truncation Distance (ft)	N/A	
Facing Option	No Facing	

Tensar® Surficial Slope Stability Solution Software

Project Name Surficial Stability in CO

Project Number D03102 **Date** 3/11/03

Client Agapito Associates, Inc. **Designer** JHL

Description **File** K:_d\D03102\surficial

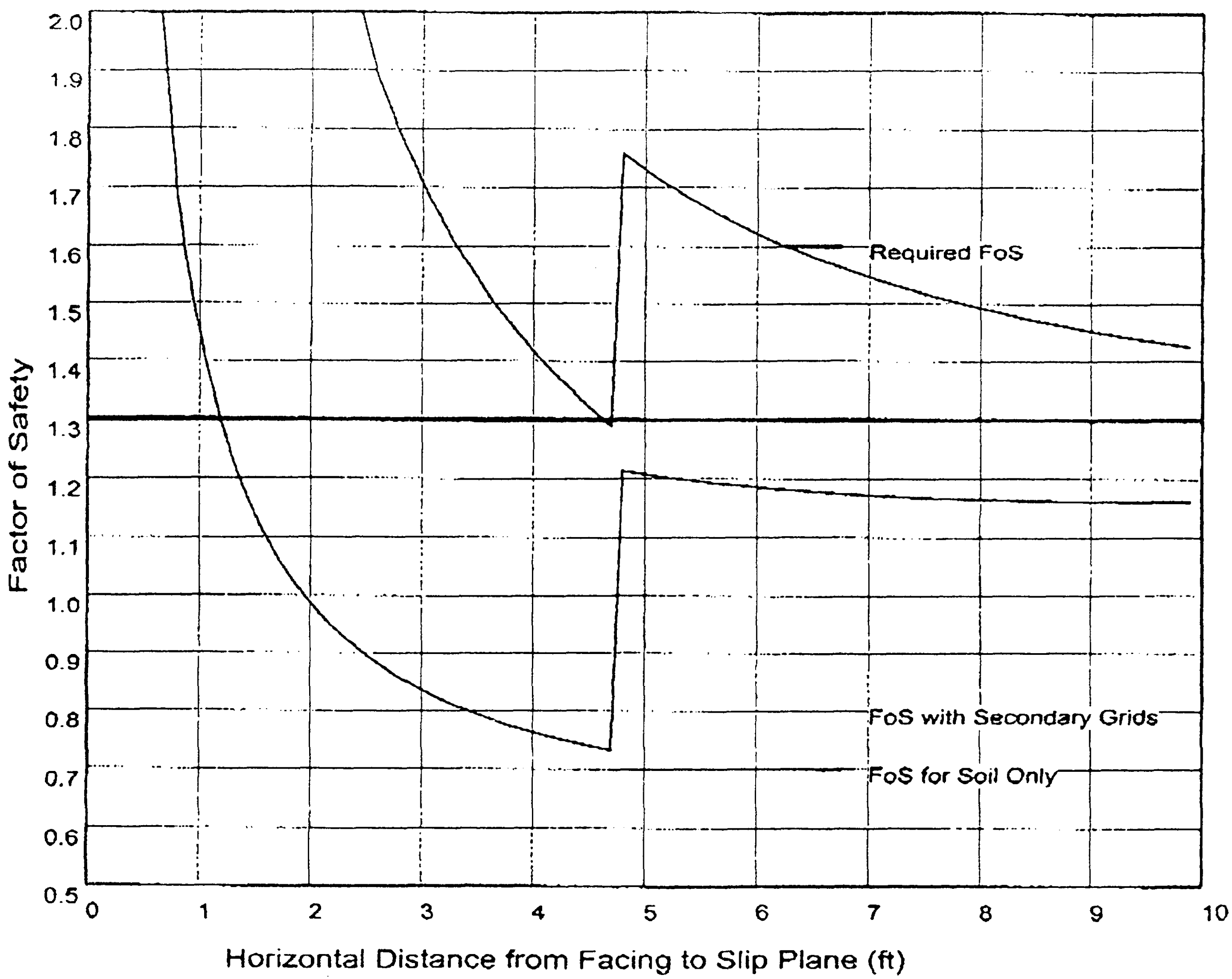
4' topsoil

Potential Failure Plane Position (ft)	FoS for Soil only	FoS with Soil and One Secondary Grid	FoS with Soil and Two Secondary Grids	FoS with Soil and Three Secondary Grids	FoS with Soil and Four Secondary Grids	Secondary Grid Mobilized Strength (lb/ft)	Min. Secondary Grid Length for Potential Failure Plane (ft)
0.10	9.82	10.80	N/A	N/A	N/A	9.57	0.23
0.50	2.38	3.59	N/A	N/A	N/A	59.28	1.01
1.00	1.45	2.96	N/A	N/A	N/A	147.11	1.87
1.50	1.14	2.88	N/A	N/A	N/A	255.00	2.67
2.00	0.99	2.29	N/A	N/A	N/A	255.00	3.02
2.50	0.90	1.94	N/A	N/A	N/A	255.00	3.40
3.00	0.84	1.71	N/A	N/A	N/A	255.00	3.80
3.50	0.79	1.54	N/A	N/A	N/A	255.00	4.22
4.00	0.76	1.42	N/A	N/A	N/A	255.00	4.65
4.50	0.74	1.32	N/A	N/A	N/A	255.00	5.02
5.00	1.21	1.73	N/A	N/A	N/A	255.00	5.42
5.50	1.19	1.67	N/A	N/A	N/A	255.00	5.88
6.00	1.19	1.62	N/A	N/A	N/A	255.00	6.36
6.50	1.18	1.58	N/A	N/A	N/A	255.00	6.83
7.00	1.17	1.55	N/A	N/A	N/A	255.00	7.31
7.50	1.17	1.52	N/A	N/A	N/A	255.00	7.79
8.00	1.17	1.49	N/A	N/A	N/A	255.00	8.28
8.50	1.16	1.47	N/A	N/A	N/A	255.00	8.76
9.00	1.16	1.45	N/A	N/A	N/A	255.00	9.25
9.50	1.16	1.44	N/A	N/A	N/A	255.00	9.74

Tensar® Surficial Slope Stability Solution Software

Project Name	Surficial Stability in CO		
Project Number	D03102	Date	3/11/03
Client	Agapito Associates, Inc.	Designer	JHL
Description		File	K:_d\D03102\surficial

4' topsoil



 Printed on: 03/11/2003 04:00PM

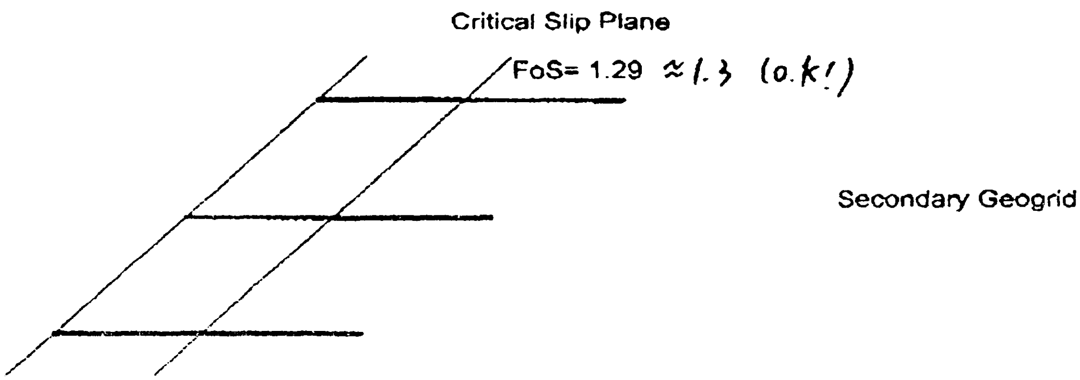
Tensar® Surficial Slope Stability Solution Software

Project Name	Surficial Stability in CO		
Project Number	D03102	Date	3/11/03
Client	Agapito Associates, Inc.	Designer	JHL
Description		File	K:_d\D03102\surficial

4' topsoil

Secondary Geogrid Requirements

Geogrid Type	Facing	Grid No.	Spacing s(in)	Min. Length Ls(ft)	Total Length L(ft)	Quantity (sy/ft)
BX1100	No Facing	1	18.0	9.80	9.80	1.09
			(1.5 ft)	(1 roll width of BX1100 40)		



Not to scale

 Printed on: 03/11/2003 04:00PM

APPENDIX 5-10

EVALUATION
OF
HIGHWALL AREA RECLAMATION
USING A
SMALLER VERTICAL ANGLE SLOPE

WEST RIDGE MINE

I. Introduction

The Division has requested an evaluation of a reclamation plan for the portal highwall area utilizing a smaller vertical angle slope. At the present time, the proposed highwall reclamation is based on providing a stable backfill with a slope of approximately 40°.

This evaluation is based on lessening the reclaimed highwall slope to 31.2° to 33.6°. This would be accomplished by shifting the proposed main channel approximately 40' to the northwest during final reclamation. This channel shift would occur only at cross-section stations 23+00 through 27+00 (Map 1) to allow the lessening of the reclaimed highwall slope. This would impact a small portion of the approved experimental practice area in which the "C" Canyon topsoil is stored "in-situ"; however, topsoil would still be protected until final reclamation and then salvaged and replaced in this area as required.

II. Proposed Plan

Under this scenario, the main channel would be relocated approximately 40' to the northwest between cross-section stations 24+00 and 27+00 during final reclamation. The highwall would then be backfilled, compacted, topsoiled and reseeded in the same manner as the other cutslopes on the site. Calculations show that by reducing the reclaimed highwall angle to 33.61° or less, and using the proposed backfill material, a factor of safety of greater than 2.4 can be attained for saturated conditions and greater than 3.6 for dry, normal conditions.

The proposed shift in the reclaimed channel will affect an area of the experimental practice "in-situ" topsoil of approximately 400' in length by 80' in width, or approximately 0.74 acres. This represents approximately 7.41% of the overall experimental practice area. The culvert and any available in-situ topsoil will be removed from this area during final reclamation. The topsoil will be replaced, and the restored channel will be rip-rapped to provide erosion protection through the reclaimed area.

The proposed area of relocation is shown on Map 1 and the proposed new reclaimed cross-sections are shown on Map 2.

III. Calculations

Stability calculations were performed using the Hoek Method from Rock Slope Engineering. Under this method, stability projections can be made using known soil characteristics such as density, cohesion and internal friction angle, as well as proposed slope height. This information can then be plotted on the provided circular failure charts to determine factors of safety for both Dry and Saturated Conditions.

Density, cohesion and internal friction angle of the proposed backfill material were taken directly from sample results from the proposed backfill material taken by West Ridge and Agapito personnel in December 2002 (See Appendix 5-9). Slope heights and angles were measured directly from Maps 1 and 2. The relevant numbers for the calculations are listed for each cross section on Table 1 of this report. These numbers were then applied to the equations on the Circular Failure Charts No. 1 and No. 5 to determine the Static Safety Factor for Dry and Saturated Conditions, respectively (Figures 1 and 2).

Based on the proposed soil characteristics and highwall slope angles, Factors of Safety for Dry Conditions run from a minimum of 3.62 to 4.30, and a minimum of 2.41 to 2.70 for Saturated Conditions.

IV. Summary

Factors of Safety for the complete highwall reclamation at West Ridge Mine can be significantly increased by shifting the proposed reclaimed highwall toe approximately 40' to the northwest. Using recently tested sample results and new proposed reclaimed slope angles, the static safety factor of the reclaimed highwall can be increased to a minimum of 3.62 to4.30 for Dry Conditions and a minimum of 2.41 to 2.70 for Saturated Conditions.

This proposed change would affect a small portion of the experimental practice "in-situ" topsoil area; however, the impact would be minor (approximately 7.41% of the experimental practice area), and topsoil could still be salvaged and replaced on this area during final reclamation.

This proposal would allow for complete and stable highwall reclamation without the need for special drains, special material and placement methods and specialized planting. However, this alternative would also require the Division to grant an AOC variance. It may also increase the possibility of future, post bond-release channel erosion due to a storm event exceeding the design of the reclaimed channel.

Table 1

<u>Move Reclaimed Channel 40' to NW</u>

Station	24+00	25+00	26+00	27+00
Toe	7045	7042	7042	7.44
Top	7150	7130	7130	7130
VD (H)	105	88	88	86
HD	158	140	140	142
Slope Angle	33.61°	32.15°	32.15°	31.20°
Safety Factor (Dry)	3.62	4.17	4.17	4.30
Safety Factor (Saturated)	2.41	2.65	2.65	2.70

Hoek Method - Rock Slope Engineering

Density (γ) = 138 lb/ft^3
Cohesion (c) = 1877 psf (Backfill)
Friction Angle (ϕ) = 54°

C=Cohesion-psf

Y=Density-pcf

H=Slope Height-ft.

ϕ=Internal Friction Angle

(DRYCONDITIONS)

CIRCULAR FAILURE CHART NUMBER 1

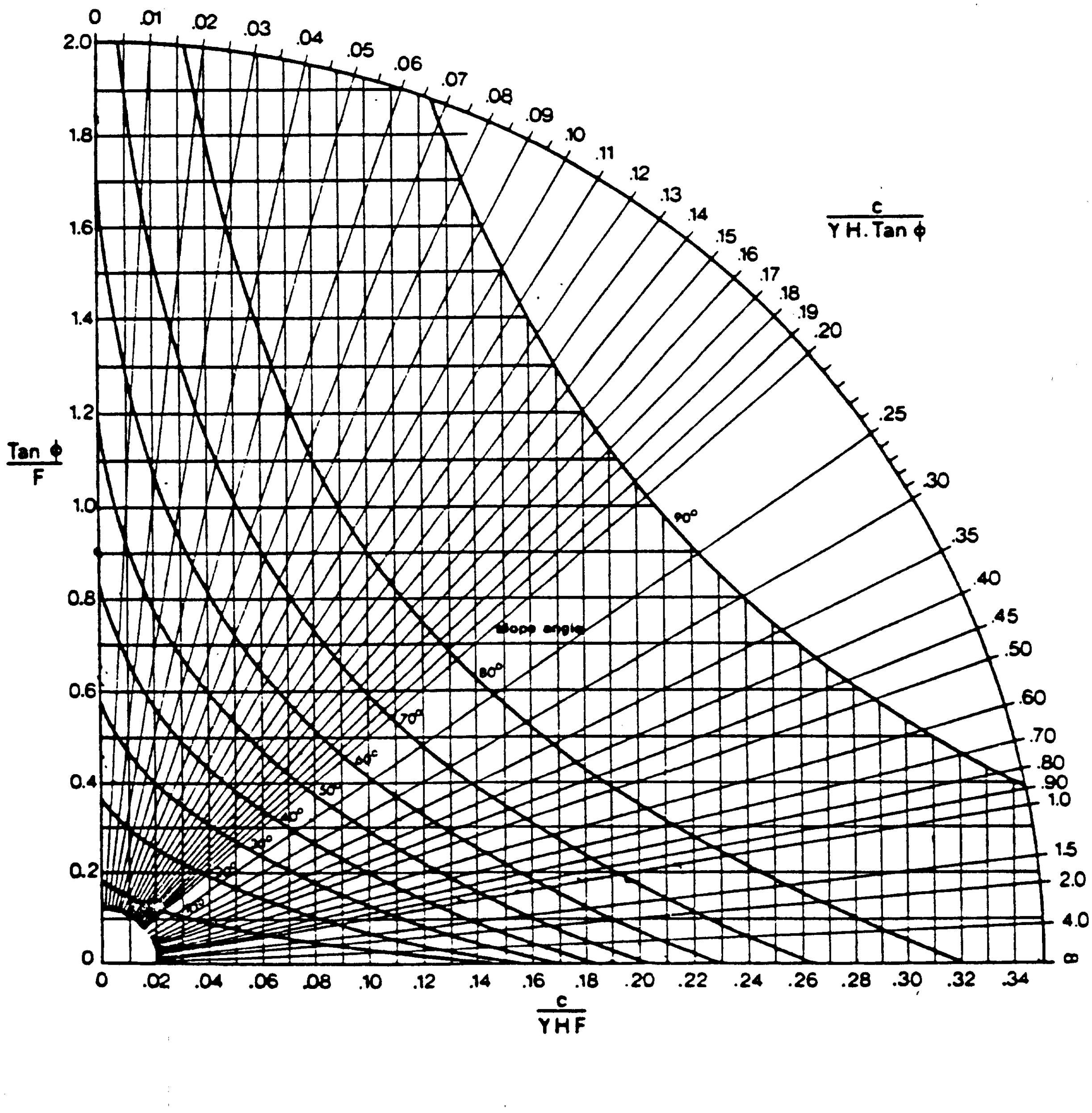


Figure 1

C=Cohesion-psf

Y=Density-pcf

H=Slope Height-ft.

ϕ=Internal Friction Angle

(SATURATED CONDITIONS)

CIRCULAR FAILURE CHART NUMBER 5

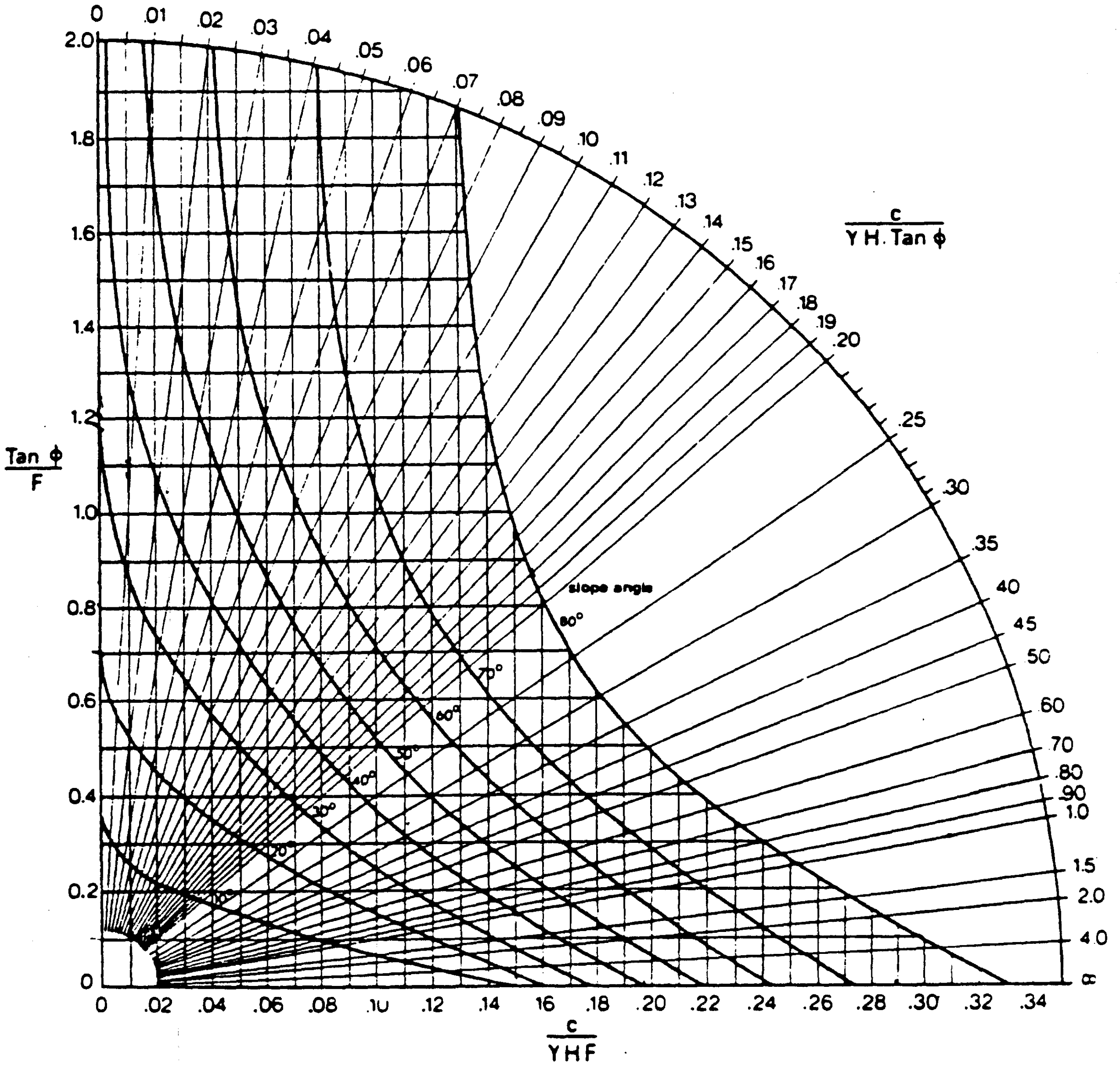
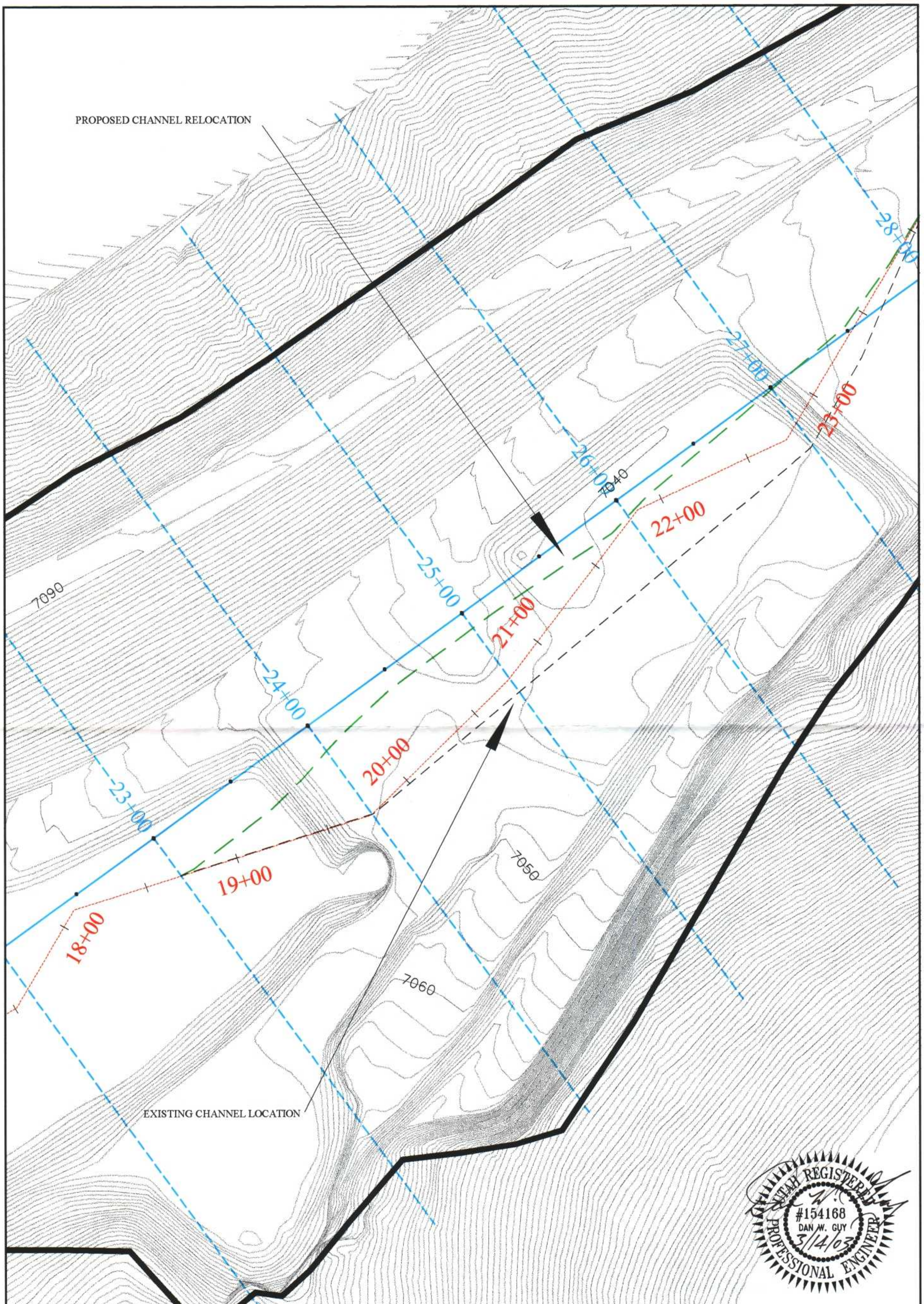


Figure 2



Legend:

Existing Channel Location:

Proposed Channel Relocation:

Scale: 1" = 50'

WEST RIDGE MINE

Map 1

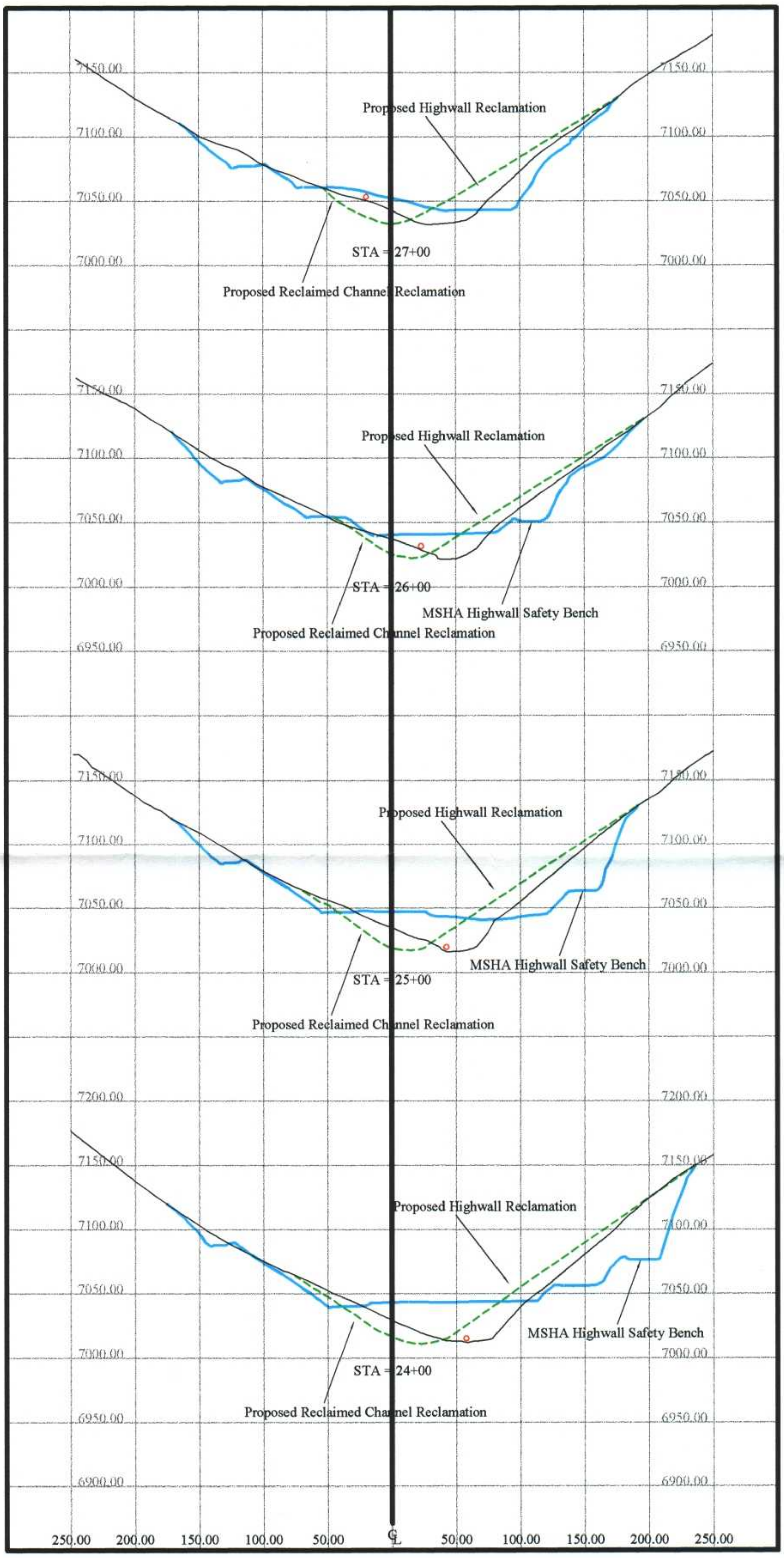
Appendix 5-10

Proposed Channel Relocation

for

Reduced Angle Highwall Reclamation

ACAD REF: Map 1 REV: 0 DATE: 03/11/03



Legend:

Original Surface	
As Constructed Surface	
Reclaimed Surface	
Bypass Culvert	

Scale: 1" = 100'

WEST RIDGE MINE

Map 2

Appendix 5-10

Reclaimed Highwall Cross-Sections

ACAD REF: X-SECTE REV: 0 DATE: 03/14/03

APPENDIX NUMBER	DESCRIPTION
APPENDIX 5-1	Reclamation Bond Calculations
APPENDIX 5-2*	Letter from Carbon County Commission
APPENDIX 5-3*	Resource Recovery and Protection Plan (R2P2)
APPENDIX 5-4*	Stability Evaluation for Construction and Reclaimed Slopes, West Ridge Mine
APPENDIX 5-5	Construction/Reclamation Plan
APPENDIX 5-6	Spill Prevention Control and Countermeasure Plan (SPCC)
APPENDIX 5-7	Pump House Reclamation and Sediment Control
APPENDIX 5-8	Letter regarding Pre-Subsidence Survey (Mayo and Associates)
APPENDIX 5-9*	High Wall Reclamation (Agapito Report)
APPENDIX 5-10*	Alternative High Wall Reclamation (Blackhawk Engineering Report)

*Not included on disk

R645-301-553 BACKFILLING AND GRADING

553.100 Upon final cessation of coal mining activities at the proposed site, WEST RIDGE Resources, Inc. will permanently reclaim all affected areas in accordance with the regulations and approved permit.

Disturbed areas will be regraded to achieve approximate original contour, eliminate highwalls and achieve a stable, long term slope having a static safety factor of 1.3. The disturbed areas will be backfilled and graded to minimize erosion and water pollution, and will support the approved postmining land use.

The postmining highwall slopes will be constructed to achieve long-term stability. The slope stability has been analyzed for the steepest highwall fill. In general, 2:1 fill slopes will be used. However, because of existing topography or physical constraints a steeper slope of up to 1:1 is planned for certain areas, such as the portal highwall area and the conveyor gallery nose-cut. The slope stability analyses are found in Appendix 5-4.

During backfilling and grading operations, the sediment pond will remain in place to minimize degradation of the undisturbed drainage. Silt fences and straw bales will be used where needed to supplement erosion and sediment controls.

The portals will be sealed and backfilled according to the design presented in Figures 5-1 and 5-2. Because all of the portals are in the same stratigraphic location and all have a highwall, they will all be reclaimed using the same design as outlined in Appendix 5-9. A block wall (seal) will be built a minimum of 25 feet inby the portal. Incombustible material will be used to fill the portal and block the entrance.

In order to comply with MSHA regulations, a minimum of four feet of incombustible material will used to cover the exposed coal seam. Where the seam has been exposed, a minimum of four feet of material will be compacted over the coal outcrop.

The area will be regraded to approximate original contour. Map 5-9 depict the final reclaimed surface configuration, and the erosion and water pollution control systems.

The post mining land use of the area will consist of the same uses that presently exist, namely, grazing, recreation, and wildlife habitat. Restoration of the approximate original contour of the mine yard will allow revegetation to be performed on the site. Native plants will be utilized in the revegetation plan. The reclaimed area will resemble the adjacent, undisturbed area and will be capable of supporting the same uses. Refer to Appendix 5-5 for the complete reclamation plan.

The success of natural revegetation within the mine yard area and areas of prior disturbance has demonstrated that reclamation of the land can be achieved. The condition and existing uses of the previously disturbed and regraded land document the throughout the entire length of the mineyard during the pad fill removal process. This will be done in order to keep the undisturbed drainage separated from the ongoing earthwork underway during reclamation. During the fill removal process, the bypass culvert inlet structures will be left in place at the upstream end of the mine site in both the right fork and the left fork. A 40' wide berm will be left intact at the upstream culvert inlets to continue to serve as the culvert headwall and to continue to divert the undisturbed drainage into the bypass culvert. By the time the pad fill has been removed and the cutslopes have been re-established, all that will remain in the canyon where the mine pads had been previously will be the bypass culvert and the backfill immediately around and over the top of it. The backfill over the culvert will continue to provide access up through the canyon for subsequent reclamation activities.

4e) Reclaim Portal Highwall: One of the primary cutslopes re-establishment projects will involve the portal highwall. Backfilling and reclamation of the portal highwall will not take place until all the excess fill has been removed (ie. hauled underground) and all other cutslopes have been backfilled to approximate the contour. By the time the highwall is ready for backfill the only reclamation phases remaining will be the re-application of topsoil, removal of the culvert, and revegetation of the newly reclaimed surfaces. During removal of the excess pad fill, a sufficient quantity of boulders (previously buried in the fill) will be segregated and hauled to the up-canyon end of the highwall cutslope. These boulders will then be used ~~to reinforce the base of the backfilled~~ in the reclamation of the portal highwall. The still-remaining backfilled culvert will serve as the primary roadway to provide the necessary access to the portal area for transportation of excess fill material into the mine works, and for boulders and backfill material used to reclaim the portal highwall cutslope.

Special backfilling techniques will be applied at the portal highwall area, and also at the conveyor nose cut. Of the entire minesite, these are the areas that involve the steepest slope cuts. The pre-existing, pre-mining slopes in these areas are as much as 40 degrees (i.e. nearly 1:1) measured from horizontal. In order to adequately access (face up) the coal seam, while minimizing the amount of hillside disturbance, the highwall cut slope will have been made as steep and sheer as safely possible during initial construction. From a reclamation standpoint the challenge of the portal area is to re-establish approximate original contour, eliminate the highwall, and maintain the stability of the backfill material in the process. This will be accomplished in the portal highwall area using methods as described in the Agapito Study in Appendix 5-9. This also will be accomplished in the ~~portal area (and~~ nose cut area~~)~~ by utilizing large boulders. Large angular boulders will be stacked one on top of the other along the outer edge of the portal bench along the toe of the slope. Fill slopes reinforced with large boulders in this manner can easily stand at the requisite 40 degree incline needed to reestablish the natural slope in this area. Regular fill material and portal face-up material (previously stored in the mine pad fill) will be used to fill in the void behind the boulders on the inside of the bench where the stability criteria is not as critical a factor. In addition, the portal face-up material will be placed inside the portal area to backfill the portal between the portal opening and concrete block seals located approximately 30' inside the portal. Broken concrete, asphalt and portal face-up material will be placed for permanent disposal within the portals ~~and along the inside of the portal bench area~~. Any face-up material used to backfill the portal bench will be covered with at least four feet of earthen backfill material.

~~Boulders, portal face-up material and other backfill, will be placed using a backhoe starting at the up dip (southern) end of the portal bench and working northward. As the boulder slope is completed, topsoil will be placed into the surface nooks between the boulders. The surface of the boulder slope will then be revegetated in the same manner as the rest of the reclaimed site. Due to the steepness of the boulder slope, some of the topsoil may slide off, leaving the boulder surface visible as bare rock. However, this rocky appearance will be very much in keeping with the natural appearance of the canyon slope in its pre-existing pre-mining conditions. In fact, in its pre-mining condition the coal seam sits atop a massive sandstone which presently manifests itself as a broad, naturally occurring, bare rock outcrop in the vicinity of the proposed portals. After it has been re-established, the reclaimed slope should look very similar to the pre-existing slope.~~

Final reclamation of the portal highwall will not take place until after the excess backfill material has been removed from the pads, transported into the portals, and placed permanently in the underground mine workings as described previously. [Note: If, however, the excess imported pad fill is hauled offsite for disposal rather than hauled into the mine, the portal highwall will be backfilled as soon as the portals have been sealed utilizing the portal faceup material stored in the mine pad.] It will be necessary to assure that an adequate supply of boulders is available to achieve the steep slope reclamation objectives described for the portal highwall, the nose cut and the nose access road. Boulders will be stored in the deeper areas of the pad fills above the bypass culvert. By being buried in the deepest part of the fill during initial construction they will be recovered lastly in the fill removal process during reclamation. Other boulders will also be stored in the sediment pond embankments and will be available for steep slope stabilization use during final reclamation. It should be noted that all principals of reclamation described herein for the portal highwall apply equally to the conveyor nose cut and the nose access road as well.

4f) Reapply Topsoil to Backfilled Cutslopes: After the cutslopes in the S/T/C areas have been backfilled and re-established to approximate original contour, the slopes will then be re-topsoiled. Topsoil will be reapplied to the slopes in the conventional manner. Topsoil will be hauled in by truck and spread with a front end loader and/or backhoe. Areas to receive topsoil will be marked with stakes indicating the depth of application. A topsoil specialist will oversee the topsoil redistribution operation. Topsoil will be left in a roughened condition prior to seeding to minimize compaction and erosion as well as promote infiltration

Map(s) is kept with this application located in the Public Information Center of our Salt Lake City office.

MAP 5-6B